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National Planning, Its Principles and Administration. ***K. T. Shah***

NATIONAL PLANNING COMMITTEE SERIES

POWER AND FUEL

(Report of Sub-Committee prepared by)

Chairman

DR. MEGH NAD SAHA, D.Sc.

Secretary

PROF. A. K. SHAHA

Edited by

K. T. SHAH,

Hon. General Secretary

National Planning Committee

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To

All Those

MEMBERS OF THE NATIONAL PLANNING COMMITTEE

and of

Its Various Sub-Committees

A TRIBUTE OF APPRECIATION

प्रारब्धमुत्तमजना न परित्यजन्ति

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of
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PREFACE

The National Planning Committee, appointed in 1938, began its work early in 1939. After defining the nature of a National Plan, and determining the nature and scope of the work entrusted to them, the Committee issued an elaborate, and comprehensive questionnaire, which was subsequently supplemented by specific details. Twenty-nine Sub-Committees, formed into eight groups, were set up with special terms of reference to deal with all parts and aspects of the national life and work in accordance with a predetermined Plan.

After some unavoidable delay in getting replies to the Questionnaire, the Sub-Committees began their work, and submitted Reports,—some of them Final, some Interim,—which were considered at Plenary Sessions of the Parent Committee in 1940. Towards the end of that year the Chairman, Pandit Jawaharlal Nehru, was arrested and sentenced to a long term of imprisonment, during which the work of the Committee had necessarily to be suspended.

On his release a year later, hope revived for an intensive resumption of the Committee's work. But the out-break of war with Japan, the threat to India's own safety, and hectic march of political events, rendered it impossible to devote any attention to such work at that time. It, therefore, inevitably went into cold storage once again; and remained there for the duration of the war.

When at last the War seemed nearing its end, Pandit Jawaharlal Nehru with other leaders was released. The moment seemed again opportune to resume the work of the Planning Committee. Meetings of that Body were held in September and November 1945, when certain more urgent questions, already included in the programme of National planning, were given a special precedence. A Priority Committee was appointed to report upon them

changes and developments occurring during the War had also to be taken into account; and another Committee was appointed to review the general instructions, given six years earlier to the Sub-Committees. Revised instructions were issued to them following the Report of this Sub-Committee; and the Chairmen and Secretaries of the several Sub-Committees were once again requested to revise and bring up to date, such of the Reports as had already been submitted —either as final or interim ; while those that had not submitted any reports at all were asked to do so at an early date.

As a result, many of the Sub-Committees which had not reported, or had made only an Interim Report, put in their Reports, or finalised them. The Parent Committee has had no chance to review them, and pass resolutions on the same. But the documents are, by themselves, of sufficient value-prepared as they are by experts in each case, to be included in this series.

The following Table shows the condition of the Sub-Committees' work, and the stage to which the Planning Committee had reached in connection with them.

Serial No.	Name of the Sub-Committee	Final Report		Interim Report		No Reports
		N.P.C. Resolutions	Not Considered by the N.P.C.	N.P.C. Resolutions	Not Considered by the N P C.	
Group I.	**Agriculture & other Sources ot Primary Production**	Handbook Pp.		Handbook Pp.		
1.	Rural Marketing and Finance	97–99				
2.	River Training and Irrigation Part I	83–85				
	,, ,, ,, Part II	113–115				
3.	Soil Conservation and an Afforestation	115–119				
4.	Land Policy and Agriculture			139–141		
5.	Animal Husbandry and Dairying	87–89				
6.	Crop Planning and Production				do.	do.
7.	Horticulture	102–103				
8.	Fisheries		do.			
Group II	**Industries or Secondary Sources of Production**					
1.	Rural and Cottage Industries					
2.	Power and Fuel		do.			
3.	Chemicals					
4.	Mining and Metallurgy			77–79		
5.	Engineering Industries	75–77		130–133		
6.	Manufacturing Industries		do.			
7.	Industries connected with Scientific Instruments		do.			
Group III	**Human Factor**					
1.	Labour	89–92				
2	Population	85–87				
Group Iv	**Exchange and Finance**					do.
1.	Trade					
2.	Industrial Finance			130		
3.	Public Finance					
4.	Currency and Banking			122–126		
5.	Insurance			93–95		
Group V	**Public Utilities**			95–97		
1.	Transport					
2.	Communications	126–129		120–122		
Group VI	**Social Service–Health and Housing**					
1.	National Housing					do.
2.	Public Health	99–100				
Group VI	**Education**					
1.	General Education			133–139	do.	
2.	Technical Education				do.	

To sum up, fourteen Sub-Committees had made final reports, of which ten have been considered, and Resolutions taken upon them, by the National Planning Committee. Twelve more have presented Interim Reports, of which nine have been considered by the Planning Committee, with Resolutions thereon; while three Sub-Committees have not yet presented any report on the reference made to them.

The idea that all this material, gathered together with the help of some of the best brains in India in the several departments of our national life, should be printed and published, was before the Committee from the start. But the interruption caused by the War prevented its realisation. It was once again mooted in 1941; but the moment was not deemed ripe then for such action, partly because the leading spirits in almost every one of the Sub-Committees were unable to devote time and labour to bring their Reports up-to-date; and partly also because war-time restrictions or shortages had made scarcer than ever before the statistics and other facts, which particular sub-committees would need, to bring their work up-to-date. The War time needs of Government had attracted several of them to work on Government Bodies, Panels, or Committees. For all these reasons it was deemed undesirable that material of this character—valuable as it must be—should be put out in an incomplete, inchoate, obsolete form, which may reflect upfavourably upon Indian capacity for such tasks.

The last four years of the War were thus a period of suspended animation for the National Planning Committee. Even after the end of the war, it has not been feasible, for obvious reasons, for the Planning Committee to resume its work and finalise decisions. Continuous Sessions of that body are indispensable for considering and taking decisions on the Sub-Committee reports presented since 1940, and putting all the material into shape, ready for publication, not to mention making its own Report; but the political situation in the country made it impossible. Other conditions, however, are somewhat more favourable than in 1938-39, when the Central Government of the county were

all but openly hostile to such attempts. Lest, however, the momentary difficulties make for needless further delay, it was thought advisable by the Chairman and the under signed that no more time should be lost in putting this material before the Public. Following this advice, it is now proposed to bring out a complete Series of the National Planning Committee's Sub-Committee Reports, which will serve as appendices to the Parent Committee's own Report. The Plan of the proposed enterprise is briefly summarised below.

Every Sub-Committee's Report, which is in a final form, and on which the National Planning Committee has itself taken resolutions, will be edited and published, with an Introduction assigning their due importance to the suggestions and recommendations, contained in that particular report, its proper place in the over-all National Plan; and following it up, wherever necessary, by a kind of Epilogue, summarising the developments that have taken place during the seven years, during which the work of the Planning Committee had been in suspension.

Those Reports, again, which, though in a final form, have not yet been considered, and no resolutions taken thereon, by the Planning Committee, will also be included in the Series in the form in which they were submitted, with such Introduction and Epilogue to each as may be deemed appropriate. And the same treatment will be applied to Reports which are 'Ad Interim', whether or not the Parent Committee has expressed any opinion on the same. They will be finalised, wherever possible, in the office, with such aid as the Chairman or Secretary of the Sub-Committee may be good enough to render. Sub-Committees, finally, which have not submitted any Report at all, —they are very few—will also find their work similarly dealt with. The essence, in fine, of the scheme is that no avoidable delay will now be suffered to keep the National Planning Committee's work from the public.

Both the Introduction and the Epilogue will be supplied by the undersigned, who would naturally be grateful for

such help as he may receive from the personnel of each Sub-Committee concerned. The purpose of these additions is, as already stated, to assign its true place to each such work in the overall Plan; and to bring up the material in each Report to date, wherever possible.

Not every Sub-Committee's Report is sufficiently large to make, more or less, a volume by itself, of uniform size, for this Series. In such cases two or more Reports will be combined, so as to maintain uniformity of size, get-up, and presentation of the material. The various Reports, it may be added, would not be taken in the order of the classification or grouping originally given by the Planning Committee nor even of what may be called the intrinsic importance of each subject.

In view of the varying stages at which the several Reports are, for reasons of convenience, it has been thought advisable to take up for printing first those which are final, and on which the Planning Committee has pronounced some resolutions. Printing arrangements have been made with more than one Press so that two or three Reports may be taken simultaneously, and published as soon as possible so that the entire Series may be completed in the course of the year.

Two other Sub-Committees not included in the list of Sub-Committees given above were assinged special tasks of (1) preparing the basic ideas of National Planning; and (2) outlining the administrative machinery deemed appropriate for carrying out the Plan. These ware unable to function for reasons already explained. The present writer has, however, in his personal capacity, and entirely on his own responsibility, published the "Principles of Planning" which attempt to outline the fundamental aims and ideals of a National Plan which remains to be considered by the Planning Committee. Similarly, he has also attampted to sketch an administrative machinery and arrangements necessary to give effect to the Plan, when at last it is formulated, and put into execution. Notwithstanding that these two are outside the Scheme outlined in this Preface, they are mentioned to round

up the general picture of the arrangements made for publication of the entire work up-to-date of the National Planning Committee and its several Sub-Committees.

The several volumes of Sub-Committee Reports, when published, will be treated as so many appendices to the Report of the parent body, the National Planning Committee. It is impossible to say when that Committee as a whole will be able to hold continuous sessions, review and resolve upon Sub-Committee Reports, which have not yet been considered, and lay down their basic ideas and governing principles for an all over Plan, applicable to the country, including all the faces of its life and all items making up the welfare of its people.

The disturbed conditions all over the country and the Labour unrest that has followed the end of the War has caused unavoidable delays in printing and publishing the several volumes in the Series, which, it is hoped, will be excused.

In the end, a word of acknowledgment is necessary to put on record the aid received by the Editor in the preparation and publication of this Series. All those who are associated in the task,—members of the Parent Committee, or as Chairmen, Secretaries or Members of the various Sub-Committees,—have laboured wholly, honorarily, and consistently striven to give the best that lay in them for the service of the country. Almost all Provincial Governments and some States,—the latter twice in some cases,—have made contributions towards the expenses of this office which have been acknowledged and accounted for in the Handbooks of the Plannning Committee, published earlier. Suitable appreciation of these will be expressed when the Parent Committee makes its own Report. At almost the end of its task, the expenditure needed to edit, compile, and otherwise prepare for the Press, the several Reports, has been financed by a Loan by Messrs. Tata Sons Ltd., which, even when repaid, will not diminish the value of the timely aid, nor the sense of gratitude felt by the undersigned.

Bombay,
1st July, 1947.

K. T. Shah

CONTENTS

POWER AND FUEL

INTRODUCTION

The Sub-Committee on Power and Fuel was appointed to deal with the following terms of reference.

(*a*) to make general survey of the present state of power supply from all sources;

(*b*) to obtain information about the cost of production, of power under different headings and of the rates charged for each kind of power supply;

(*c*) to survey the potential resources of generation of power (from water, steam, oil, wood, industrial alcohol and other sources);

(*d*) to recommend measures for development of cheap and abundant power supply for the work contemplated by the National Planning Committee.

(*e*) to examine the present state of the law in regard to electric undertakings and suggest amendments if necessary.

The Industrial Revolution, beginning towards the close of the Eighteenth Century in Britain, consisted largely in the substitution of mechanical for human energy in all manufacturing industries to meet the primary needs of man. Perhaps the most vital single requirement of mechanised industrialisation of the modern type, with large-scale operations with the aid of the machines, is steam or electrical energy which helps to economise labour, and at the same time increase the yield per unit of work.

The ambition of this country for large-scale industrialisation has, however, been handicapped, almost from the start, not so much by lack of resource in the shape of material or man-power, as by two external factors. A subtle hostility in the attitude of the Government of the country in the matter of its industrial growth, and the consequently unsympathetic

policy adopted towards the development of industry which would compete with British Industry in the Indian Market are responsible, in the final analysis, for India's industrial backwardness. More important for immediate reaction is the lack of the necessary power for driving and working complicated machinery.

The main sources of energy for driving machinery in modern industry are coal, petroleum or fuel—oil, and electricity. In proportion to her size and resources of raw materials and man-power necessary for large-scale modern industry, India is poorly endowed in regard to coal and petroleum or combustible oil. It may be that all the possible coal resources of the country have not yet been fully explored. A much smaller proportion is actually exploited than may well be expected. It may also be that the country's oil resources are similarly also not developed to their full potential. Making full allowance, however, for these factors, it must be admitted that, comparatively speaking, India is poorly endowed in the matter of these essential requirements for modern, mechanised industry and mass production.

If, therefore, India desires to realise her growing Industrial ambitions, she must find adequate energy. If coal and oil are lacking, a substitute,—economical as well as plentiful,—for these sources of energy must be found. That substitute is available in ample measure in the Hydro-Electric resources of the country, which it is possible to develop in almost all the parts of the country from the perennial rivers that flow through every Province in the land.

Given modern technique and scientific advance in regard to the production and distribution of hydro-electric energy, even those regions which have no great mountain streams can have, by suitable location of power generating stations, and adequate utilisation of the rain water, sufficient arrangements for the production and supply of electrical energy for all their likely needs under an intensive system of industrialisation. According to estimates made by experts, hardly 2% of the potential hydro-electric energy in the country is now explored and utilised. One of the first pre-requisites, therefore, is to have an up-to-date and exhaustive survey of the water

resources of this country, co-ordinate the various ways in which these resources can be developed, and the several uses to which they may be employed; and prepare a comprehensive programme for the setting up of the necessary generating plants, building the required dams, training rivers and using their waters in the most economical manner possible for industry, agriculture, transport, and other requirements to which water can be put.

The Sub-Committee has surveyed the problem in all its bearings, and noted some of the handicaps from which our existing power industry, such as it is today, suffers. Electrical energy is still very costly in this country; and the development of many industries which require cheap and plentiful supply of power for successful working, is retarded for lack of this indispensable pre-requisite of modern mechanised large-scale production. No small part, therefore, of the Report has been devoted to analysing the charges and showing them to be disproportionately high.

The necessity recognised by the Sub-Committee of a well organised and well distributed national system of generation and distribution of electrical power can be met, only if the entire enterprise of production as well as the supply of this energy is made a Public Utility Concern. It would be needless and reprehensible waste of national resources, if, after building such stations and providing their equipment, they are left to be worked by private enterprise for its own profit. The entire enterprise, utility, and service must, therefore, be owned, controlled and managed by the State, or a Statutory body specially created for the purpose, and acting on behalf of the community in the interests of the entire National Economy. The profit motive must be excluded from the operation of this enterprise: otherwise the service will be neither as widespread, as cheap and as abundant as it is required to be; nor productive of the benefits anticipated.

It does not necessarily follow from this that it would be a net loss to the country even if the first consideration in utilising this energy is its plentiful supply at economic rates for power needed for industrial or domestic use rather than a commercial profit for the producer.

The production of electrical energy on a large scale, properly co-ordinated and scientifically distributed all over the country, will more than off-set the disadvantage of high cost and low rates. Besides, in hydro-electrical enterprise, even though the initial capital cost of setting it up may be comparatively heavy, as it involves damming rivers, acquiring land, and providing the necessary machinery, plant and equipment, the maintenance cost would be relatively much lower. If the profit motive is eliminated from this enterprise, as it should be, the charges for the power or energy supplied, utility provided, or service rendered, can easily be framed, so that not only will it be accessible to every village, but also to every industry that can be economically operated by such driving force. It will be more necessary to treat it as a Public Utility, as the operations will be spread over several units of the Federation, i. e. Provinces as well as States, whose concurrence and co-operation are indispensable for starting and working this enterprise. Such co-operation will be readily available, only if the matter is handled as a collective Public Enterprise, and the principle is adopted of **service before profit** in such matters.

The uses of Electricity are many and varied, and increasing every day. The vast net-work of Railways, which admits, of considerable further expansion, would be much more economically operated than is the case today, if, instead of the wasteful steam-power generated from a relatively low-grade coal, hydro-electric power was used for haulage all over the tracks. As against the 42,000 odd miles of rail-road operated by steam a few hundreds are worked by electricity. The other considerable form of modern transport, the automobile, would also be much more useful and popular in this country, if the driving energy were electricity rather than petroleum. The great vested oil interests in America and elsewhere have prevented uptil now adequate scientific research being carried on for automobiles to be driven by electricity which would hurt the petroleum producer in a vital spot. No wonder India feels unnecessarily handicapped for lack of adequate supply of petroleum within her own frontiers in developing the use of the automobiles for passenger or goods carriage in the country.

Were electricity substituted for oil, the handicap will disappear; and the country's economy as a whole immensely benefited.

One of the important features of the National Plan, as conceived in this Series, would be a large-scale development of roads. As against the 60,000 odd miles of proper roadway in the country, plans even now made suggest a minimum of 200,000 miles being provided if the country, its industry, agriculture and domestic needs of the masses are to be adequately served. On these roads the form of traction most suitable and economic would be the Automobile. But the means of transport would be wasteful, and unable to rise to its maximum potential, unless the energy necessary to drive it is derived from indigenous water-power turned into electricity, rather than from foreign imports as is the case with petroleum today. It is worth considering, therefore, by those who are charged with the preparation and execution of a National Plan for India, whether intensive research should not be devoted to find ways and means whereby India can be independent of foreign supplies of petroleum, and provide her own traction power by hydro-electric energy.

Apart from these demands for electrical power, which, as stated above, are capable of great expansion, industry of every type, agriculture, utilities as well as the essential social services, will require progressively more and more energy, as Industrialisation proceeds, and the people's standard of living improves. The suggestions made in another volume of this Series, for developing culturable waste land as industrialised agriculture; for improving forests and fisheries, would also be very much facilitated and expedited if cheap and abundant supply of energy is available.

For all these reasons the recommendations of the Sub-Committee that the production and supply of all electrical energy be a Public Utility Concern, owned, controlled and managed as a State enterprise, and worked on the basis of a vast national grid, wherein all units of the Union of India co-operate with the Centre, is eminently commendable and should be given effect to as soon as possible.

The co-relation between Hydro-Electric Power and Water Supply for irrigation has also been emphasised by the Sub-Committee. It is further developed by another Sub-Committee which deals with River Training and Irrigation Proper. The essence of the recommendations in both cases is a carefully planned all-round co-ordination and systematic execution of the programme, so as to serve adequately and satisfactorily the interests of the entire community in every aspect of its economic life.

The Sub-Committee has recommended the establishment of a Central Technical Power Board to carry out a systematic survey of the hydro-electric resources of the country, and adopt such schemes for the development of these resources within a given time as may be found practicable. This Board should be an integral part of the Planning Administrative Machinery that may be devised, so as to maintain the process of all-round co-ordination. The National Planning Committee have accepted these recommendations, and urged the establishment of a Central Electricity and Fuel Board both working in concert and supplemented by Regional or Provincial Boards. All these are to be Statutory Bodies, and the sole vendors of Electricity in bulk. They would put up, wherever suitable, their own Power-Stations for generation and distributive channels, carry out surveys for new projects where necessary, and examine schemes of generation and supply when prepared. The same authority would also have to consider the rates or charges made for electrical energy, in bulk or retail, and to standardise equipment for this purpose. In this way the entire service will be maintained in unison and the particular needs of each region duly attended to.

While giving full importance to Hydro-Electrical Energy, its production and distribution, as a real solution of India's power problem in a programme of industrialisation and planned national development, the Sub-Committee are not, unmindful of the alternative sources of energy. They have made several recommendations on these other sources of coal, oil and power alcohol.

Coal, as already mentioned, is in this country deficient in quantity as well as quality. But, even so, the methods of its production and distribution can be substantially improved, so as to increase the total wealth of the country, and make it more easily available, in places where electricity is not similarly accessible.

Several Committees have in the last few years considered the problem of coal mining, including economic production of coal and its regular supply. The objective and outlook of some of these Committees which have reported on the subject may be somewhat narrow in comparison with that of the Sub-Committee of the National Planning Committee which has considered the problem of power and fuel supply. Certainly, if Electric Supply is to be made a Public Utility Concern, coal,–its substitute or alternative,–cannot be left to private profit-seeking enterprise, whether in mining or distribution. Coal mining must accordingly be nationalised; and the material supplied to every industry or occupation needing it as cheaply and regularly as possible.

The larger question of national policy regarding the exploitation of the natural wealth of the country, like its minerals need not be considered here. It is a matter of basic National Policy, which the National Government will have to determine after due regard to all relevant considerations. Whenever the matter is finally determined, proper correlation with the ownership, management, control and utilisation of electric energy must be observed. It must, at the same time, be emphasised, that Coal, however inadequate in quantity and poor in quality in proportion to our industrial ambitions, is an important source of energy, which any country, seeking to be highly industrialised, cannot ignore. Accordingly, just as there is a need for a systematic survey of the available hydro-electric resources of the country, so too is it necessary for a new geological survey of all parts of the country with reference to Coal as well as other Minerals. It is not impossible that more Coal Deposits may be discovered by such a survey with modern tools and methods in several parts of the country than have been so far discovered and exploited. Whether

they are discovered or not, the fuller utilisation of existing resources must not be neglected; so that the power needs of the country in respect of energy may be met as fully as possible.

The use of Forests as a source of fuel is wasteful and disastrous, if the country is to realise at all her industrial ambitions. There are other and more profitable purposes for which Forests may be reserved. Wood should be altogether left out as a source of power supply, whether as an alternative or a supplement to coal or electric energy. India has vast forest resources, no doubt; but the timber she produces can serve much more profitable purpose; and the other forest produce is suitable to serve as raw material for new industries far more advantageously than being wasted as today.

The Petroleum resources available in the East and North West corners of the country are scanty, and inadequate for even our existing needs. It may be that these are also capable of further development and expansion. But so far as is known today, they are unlikely to yield in the near future quantities sufficient for the programme of development envisaged by the National Planning Committee. Since August 15, 1947, when the country was partitioned, the Union of India has become still more poor in regard to petroleum resources by the loss of the attok oil.

The only other alternative that may be and has been considered by the Sub-Committee is in regard to Power Alcohol. Large quantities of this cheap fuel are possible to produce by the Sugar Factories that have sprung up in the several parts of the country in great numbers in the last few years. The economics of Power Alcohol need not be considered at great length in this Introduction. The Sub-Committee has given full consideration to the matter in their Report, and we must leave it to speak for itself. Scientific opinion seems to be agreed that there is a great possibility for additional supply of energy from this source; and the Planning Authority of the country will have to consider ways and means for giving effect to the same.

K. T. SHAH

Summary of the Final Report of the Sub-Committee on Power and Fuel

Part A

ELECTRICAL POWER

1. Total Production of Electrical Energy in India

The production of electrical energy in India is exceedingly small—no up-to-date authorised returns are available, but according to the Government of India estimates amounted to 3860 million units in 1942, which works at the rate of 9 units per capita per year. The resources available, which have been very unsatisfactorily surveyed, indicate that with a progressive policy, the output can be increased 50 times and may be within a reasonable period of time.

2. Per Capita Production Compared to other Countries.

The per capita production of electrical energy is one of the lowest in the world, comparable to China or Abyssinia before 1936. It can be compared to the figures of nearly 2380 for Canada and 130 for Mexico in 1938. Nothing is a better index of India's industrial backwardness than this figure for electrical energy production.

3. Energy Production from all Sources.

It is very difficult to estimate the total energy production from all other sources — human, animal, steam and petrol, wood, baggasse and other combustible matter. But the total cannot be more than 100 units per capita per year. It is nearly 15 times less than the standard for civilised countries.

4. Hydro-electric Development Indispensable for Indian Industrial Expansion.

Large tracts of India must depend upon the development of water power resources if industries in these parts are to be efficiently and economically organised. The first requisite is an adequate survey of water power resources of India, which does not exist except the preliminary survey by J.W. Mears in 1923, which is admittedly insufficient. Surveys have, in the meantime, been carried out by some Provincial Governments and States; but except in a very few cases neither in quality nor quantity do they come up to the standard of surveys in Canada, Sweden or Italy. According to Burrows the total hydro electric resources of India come up to 30 million kilowatts. This appears to be a more correct guess than that of Mears. According to the information of the Government of India of this only 426700 kilowatts of continous power have been installed in 1942 so that only 1.4% of the potential hydro-electric power has been developed upto 1942. In most of the European and American countries the percentage of potential power developed varies from 15 to 90%.

5. Power Development—the most vital factor in Industrialisation.

It is very imperfectly realised that power development is the most vital factor in industrialisation. The amount of ignorance, and faulty information amongst the public and officials regarding the part played by power in developing the country's industries, transportation and national life in general, is simply colossal.

6. Need of enunciating a National Power Development Policy.

The backwardness in power is due to the absence of a definite National Power Policy on the part of the State. As a result of the World War of 1914, all countries were compelled to adopt a definite National Power Development Policy – aiming at the development of all possible resources, and their proper utilisation; but in India, though such a policy appears to have been in contemplation as a result of the recommendations of the Indian Industrial Commission of 1918, all work on this line

was stopped by the Central Government in 1921, and transferred to the provinces.

7. Need for amending the Indian Electricity Act.

The law relating to the generation, distribution and supply of electrical energy in India (known as the Indian Electricity Act) was drafted in 1903 and has not undergone any substantial change since then. It is, therefore, out of date and needs modification with a view to foster a more rapid development of electricity for development of industry. Even the insufficient safeguards (as for instance appointment of Electrical Advisory Boards) recommended by the Act have not been given effect to by the Government.

8. The present high rates for energy, their causes and proposed remedies.

Except in a very few cases, the rates for energy are unduly high and could be considerably reduced. In the case of the grid schemes and other large undertakings, the domestic rates are too high and it should be possible to reduce them progressively. In most cases the high rates are mainly due to the present low load densities and low load factors resulting in an unduly small revenue in relation to the cost of works. In smaller undertakings, they are also due to the generation of power in small inefficient powar houses for supplying small urban areas. In some cases, in spite of progressive improvement of load conditions and in the technical efficiency of the schemes, the supply companies have failed to reduce rates correspondingly. In order to improve this state of affairs, the following measures are proposed:—

1. The entire system of electricity supply in each province should be reorganised by bringing under review all the existing power stations and preparing schemes for supply to much more extensive areas, both urban and rural, from a very much smaller number of large efficient power stations, thermal and hydro-electric, feeding into grids for supplying all loads within these areas. This proposal is similar to the recommendation of the Veir Committee in accordance with which reorganisation of

power supply has been carried out in England with very satisfactory results.

(2) Reorganisation of the large number of existing distribution systems based on the retention and utilisation where possible, of the larger and more efficient of the existing undertakings and the absorption by such undertakings of the smaller and less efficient of the existing undertakings or the amalgamation of the existing distribution undertakings. In all cases, the undertakings taken over should receive a fair price for the assets and reasonable compensation for the loss of future profits.

(3) The Electrical Power Board should be empowered to require distribution companies (a) to carry out approved schemes of extension for undeveloped areas and (b) to offer facilities for the hire or hire-purchase of apparatus and for assisted wiring.

(4) The Electrical Power Board should be empowered to require all distribution companies to offer an approved two part tariff for domestic supplies as an optional alternative to a flat rate charge.

Proposals (2) to (4) are similar to the recommendations of the Snell Committee on Electricity Distribution in the United Kingdom.

The cost of works and operation and consequently the rates for supply could be reduced if (1) all electrical equipment is standardised as far as possible and manufactured in this country; (2) Indianisation of staff effected; and (3) purchase of stores and equipment made in competitive markets.

As it appears that in some cases the high rates are also due to financial manipulations on the part of holding companies and Managing Agents, it is necessary that the operation and accounts of all undertakings should be controlled by the Electrical Power Board as detailed under para (15).

9. Implications of the Industrialisation Policy adopted by the National Planning Committee.

According to the red book published by the N. P. C. (page 40, 11) the industrial output of India is to be increased 2 to 3

times within the next few years and five to six times ultimately. For the total industrial output contemplated in this and other resolutions, the total energy production in India from machinery has to be increased to at least 35,000 million units within the next few years, part of which may be forthcoming from steam engines, but most can come only from electrical power. According to our estimate about 12,000 million units of energy should be electrical and this would require installation of additional electrical plants with a total capacity of about 3 million k.w. assuming that the load factor can be improved as we have visualised in 8. According to our investigations, the total capacity of electrical plants now installed in India is about 1. 15 million Kilowatts, with a capital of about 90 crores of Rupees. The total capital required for the developmental Work we have in view would be about 240 crores of Rupees

10. Case of State Control of Power Development and for Existing Power Companies.

The electricity development in India has so far been confined mainly for the service of the cities and larger towns, Railway workshops and a few centres of heavy industry. Both fuel and hydro-electric power stations built by State and private agencies are in service. These developments have generally been of a character where loads are concentrated and therefore the promoters of the undertakings did not have to wait for long before the investments began to yield returns. Further developments of electrical power, however, would mainly have to be of a different character. New power stations and/or extensions of existing stations and new loads have to be planned together. The new loads would be the power demands of the heavy chemical and manufacturing industries and making electric power available to the smaller towns and to the countryside for small industries, lift irrigation, protected water supplies, etc. The latter demands are particularly pressing needs in the interests of the economic well-being of the bulk of the population of the country which lives away from cities and towns.

The different demands of the new power developments can be best served by the establishment of central, thermal and

hydro-electric power stations and networks of transmission and distribution lines. Such power schemes have been planned and are now in operation in Mysore and parts of United Provinces, Madras and Punjab and North Western Frontier Province. As such schemes have necessarily to be planned in relation to conservation of fuel resources, joint use of river flow for irrigation and power, river and drainage control etc., we consider that the State should take the initiative in bringing into existence the future regional power developments as indicated above to accelerate the uses of electrical power.

11. The Control Machinery for Power Development.

The control machinery should comprise two separate Boards (a) the Electrical Power Board (b) the Fuel Board, each acting through a number of surveys, committees, research and standardisation stations. The two boards should work in close co-operation, whenever necessary, in problems of common interest.

12. The Hydro-electric Survey of India.

The duties will be to make a survey of the hydro-electric power resources not only of British India, but of the entire drainage basins of India, even though a part of them might be under the territorial jurisdiction of neighbouring chieftains, and rulers, e. g. Nepal and Bhutan. Such a survey should include, *inter alia* the location of power resources, accessibility, head water supply, storage, capacity, regulation of flow, the amount of silt carried in the water, silt deposit, the geomorphological, climatic, orographic and anthropo-geographical data and hydro dynamic curves of the basins. There should be adequate collection of data on steam and ground water gauging, rainfall records and run-off and snow-gauge records (at high altitudes) for fairly long periods. In mountainous regions, there ought to be a programme of glaciers study which should include information about precipitation of snow and temperature of snow, atmospheric pressure, direction and force of wind, solar radiation, condensation and in fact all the elements which, together with stream measurements, permit the control of ice-storage, so extensively utilised in hydro-electric plants.

Since water power used for electric generation is closely linked with flood control, drainage of marshes, soil conservation, navigation, irrigation, afforestation or even recreation, the above mentioned Survey should act in close co-operation with bodies dealing with these matters.

The Hydro-electric Survey of India should be an All-India body with suitable head quarters, should be of the same status as the Trigonometrical or Geological Survey of India, and should work as a co-operative body of the National Water Power Resources Commission. Under its direction, survey work should be carried out by provincial agencies wherever possible or by its own staff, when provincial agencies are not available. The survey ought to be undertaken according to the natural hydrological divisions of India e. g. the Ganges Basin, the Indus Basin, the Western Ghats, the Godavari, the Mahanadi, the Damodar etc. It should be a permanent body like the Royal Water Power Board of Sweden or the Hydro-electric Power Commission of Ontario in Canada. All records and data should be analysed at the headquarters station.

13. The Industrial Load Committee.

The functions of the Industrial Load Committee of the Electric Power Board would be to plan for the maximum utilisation of the power already developed, or to be developed in future. It should do so in consultation with provincial agencies and manufacturing concerns.

14. The Railway Electrification Committee.

At present, except for a little over 200 miles of electric railway, all the Indian railways amounting to nearly 40,000 miles are hauled by coal-fired locomotives. About 7½ million tons of good coal are used for running them. Except in the eastern part of India, most of the coal is long-haul and therefore costly. For efficiency and for conserving the very limited coal reserves of India, it is desirable that a policy of railway electrification be adopted. It is bound to be a slow process. This matter will be gone into by the Committee which would work in conjunction with the Railway Board. It would decide

the portions to be first electrified and the pace for electrification. It shall gather all the data necessary for electrification.

15. Electrical Utilities' Control Committees.

It is recommended that Electrical Utilities' Control Committees be formed, in the centre as well as in the provinces, to exercise a rigid control on the existing electricity supply companies, as well as on the growth of future companies on the right lines. The control is to be exercised on private as well as state undertakings in the interest of the consumer. The Central Body (corresponding to the present Central Electricity Board) would advise the Government on legislation, would act as an appellate body for disputes arising in the provinces and would give directions to all provincial bodies. Administration of the Indian Electricity Act should be left to provincial bodies. Functions similar to those are specified for the Central Electricity Board in the Indian Electricity Act of 1937; but the Provincial Advisory Boards recommended in the act have never been constituted. The act should be modified on the lines recommended below :—

(a) Knowledge of the detailed working of undertakings.

The financial as well as the technical working of every electrical undertaking should be known to the State in a much more comprehensive manner than that visualised by the existing Indian Electricity Act. The form prescribed by the Indian Electricity Act of 1937 should be replaced by that adopted in England with necessary modification.

(b) Collection of their technical and economic data.

The Committee should gather data about the efficiency of power generation and distribution by the various electricity undertakings whether Government-owned or Company-owned and their characteristics. The capacity of the undertakings for efficient development in the future should also be fully assessed. The load characteristics of the areas served by the various undertakings should be determined. Such characteristics should include the load-factor, the diversity factor, the daily, monthly and annual load-curves. Such data should be kept up-to-date.

(c) **Inefficiencies to be remedied.**

The Committee should analyse and examine such data as can be gathered and should determine the methods by which inefficiencies, wherever they exist, in generation and distribution can be remedied and should also determine to what extent existing distribution areas should be reduced, re-organised, increased or remodelled in order to realise higher standards of efficiency and lower rates to the public. Such a determination should include amalgamation and co-ordination of supply undertakings. The Committee should also recommend the terms of payment to the companies and local authorities where it is necessary to transfer areas of supply from such undertakings to administration and control of other undertakings.

The Committee should not wait till it has completed its review of the whole country but should submit its schemes from time to time as far as specific areas are concerned, so as to enable them to be put in operation.

(d) **Collection of Financial details about the undertakings.**

Appointment of auditors by the E.U.C. Committee.

It is important that the accounts, a statement of which would be normally furnished to the Government by the undertakings themselves, should be audited, not by the auditors appointed by the undertakings as at present, but by auditors appointed by the Committee.

The auditors appointed by the Committee will have not only to see that there is a voucher for every payment but will have also to see that the payment itself is such as an ordinary business man of prudence would incur.

(e) **Reduction of rates charged for electricity.**

It would be the duty of the Committee to examine at the end of each financial year whether the reduction in rates (which ought to be a regular feature) was proper, if not, it should enforce the proper reduction.

The Committee should further see that the total reduction has been apportioned properly to different classes of consumers.

The Committee should prescribe model forms of tariff where such prescription is deemed necessary in the national interest and in the interest of standardisation.

(f) **Depreciation and Reserve Funds.**

We believe that it is improper to let the undertakings be absolutely free in fixing depreciation and other reserves at their sweet will. We recommend that the various Provincial Governments should fix definite percentages of the income, after deducting the expenditure to be devoted to depreciation and other reserve funds. Such percentages should be based on the character of machineries, plants, etc. which might be in use.

It would be the duty of the Committee to arrive at these percentages and recommend them to the respective Provincial Governments.

(g) **Relation between the electrical undertakings and their Managing Agents.**

It has been found that at least in some cases, the terms of contract between the electrical undertakings and their managing agents are such as to give to the latter inordinately great advantages — naturally at the expense of the consumers. We recommend that the terms of such contracts should be thoroughly examined by the Committee in light of the new Companies' Act. The Committee may either recommend the Provincial Governments to have the contracts revised or to have only reasonable emoluments paid to the managing agents out of the net profits of the undertakings and the rest to be paid, under the terms of the contracts, out of the portion of profits for shareholders.

Any new contract with the Managing Agent should have its terms approved by the Committee and suitably modified if it be unapproved.

(h) **Change of hands on the part of Electrical Undertakings.**

The Committee should see that no licence should be transferable, except to a Company which may be floated for the purpose, and that undue privileges are not paid to the original

licencee for the services he has rendered in securing the licence. Any privileges so obtained by the original licencee, as for instance the Managing Agency of the Company to whom the licence has been transferred, are not transferable without the express sanction of the Committee.

(i) Holding Companies –their control.

In India the Holding Companies are not supervised at all. The McGowan Committee's proposals on such holding companies in England are instructive. That Committee proposed that: (1) the accounts of holding companies controlling operating companies should be subject to the official audit and that (2) at enquiries on the rates of a subsidiary, account is to be taken of the profits of the holding company in dealings with this subsidiary. We are of opinion that some such control on the holding companies should be exercised, even in India.

"The maximum returns allowed on capital advanced by holding companies on short-term advances and loans should not be greater than 1 per cent above bank rate, and on long-term loans 1 per cent above the current rate of yield on Consols".

(j) Alterations in the plant and equipment to be sanctioned by the Committee.

In order to avoid costly schemes being adopted by the electrical undertakings, to ensure that any capital expenditure is in the best interest of consumers, to enforce the use of Indian made machinery and plants (when such articles are made here) to standardise the character of supply, its frequency and voltage and to enable the training of proper technicians, we recommend that any addition to and alteration in the existing plants of electrical undertakings should have a prior approval of the Committee.

Any scheme or design which an undertaking prepares, should first be submitted to the Committee before it is actually adopted.

In case the Committee does not approve of it (and it must assign full reasons for its disapproval) the undertaking

will have to alter it, till it meets with the approval of the Committee.

(k) Hire purchase system of initial installations.

In order to enable a larger number of people to enjoy the amenities of electricity, who cannot do so at present, because of want of money to meet the fairly heavy initial expenditure incurred in wiring out and connection of their premises, and in making a change over from oil and steam engines to electric drive, we recommend that the Electrical Power Board should be empowered to require the electrical supply undertakings to offer facilities for hire and hire-purchase of apparatus and assisted wiring on easy terms.

In areas served by poor undertakings, Government itself should, on the recommendation of the Committee, come forward with such schemes.

These schemes should also include the extension of electricity to outlying areas.

(l) Ways and means to put into effect our recommendations.

In order to ensure that the above-mentioned recommendations are given effect to by the various electrical undertakings in India, they should have a formal legal sanction. We recommend that the Indian Electricity Act should be revised and redrafted so as to incorporate provisions dealing with the above points as well as others equally important but not specifically indicated by us.

We further recommend that 25% of the Directors should be nominated by the various Provincial Governments on the Board of an electrical undertaking. The Directors should be men, well - versed in the economics and technique of electrical power - production and supply, and should be chosen on the recommendations of the E.U.C. Committee.

We are further of opinion that the Government should hsve option to purchase any electrical undertaking after the expiration of 25 years from the commencement of the licence

and thereafter on the expiration of every subsequent period of 5 years therefrom. The price to be payable for such a purchase would be the existing value of the property at the service of the public in the same sense as we have said above.

In order to bring about an uniformity in the Government's policy with regard to H.E.resources, we should further recommend that those H.E. Power Plants which are in private hands should be acquired by the State, as was the case in Madras. Madras Government bought back the Pykara concession from private hands, to which it had been granted earlier, when it had adopted a definite policy with regard to H.E. development and survey.

16. Standardisation, specification, research and training of technical staff.

From the point of view of economy, it is desirable that designs and specifications for similar equipments and materials should be standardised as far as possible and it is recommended that all necessary standard designs and specifications should be prepared and issued by the Electrical Power Board.

The Board shall also consider the question of necessary research work in connection with electricity supply, formulate the problems and arrange for the research work to be carried out in suitable laboratories or in the field.

PART B

Fuel, Solid, Liquid and Gaseous.

In this report, we have discussed the problems of Indian Coal and other kinds of fuel relating to processing, utilisation and distribution from the point of view of a unified fuel balance for the whole country.

1. Uses of Coal.

Coal is used in India for the production of electrical power, for the running of railways, for propulsion of ships. for running other industries with steam power, for smelting purposes, for

such industries as glass, cement, etc. and for domestic purposes. A small quantity is used for conversion into gaseous fuel. In other countries it is used as a source of raw material for the manufacture of a large number of chemicals of great economic value, and for conversion into liquid fuel, when mineral liquid is not available.

The total production and consumption of coal under different headings are given below:—

TABLE I

Total production of Coal in India.

Year	1935–36	1936–37	1937–38	1938–39
Total production in million tons.	20.87	20.06	23.479	24.8

Consumers	Estimated consumption in 1927(tons)	% total	Estimated consumption in 1935 (tons)	% total
Railways	7,259,000	33.5	7,259,000	31.9
Admiralty and Royal Indian Marine	27,000	0.1	29,000	0.1
Bunker Coal	1,317,000	6.1	1,020,000	4.5
Jute Mills	935,000	4.3	653,000	2.9
Cotton Mills	830,000	3.8	1,531,000	6.7
Iron Ind. including enginering workshops	5,260,000	24.2	5,583,000	24.4
Port Trust	205,000	0.9	135,000	0.6
Inland steamers	636,000	2.9	551,000	2.4
Brick, Kilns, Potteries, cement works etc.	565,000	2.6	792,000	3.5
Tea gardens	223,000	1.0	186,000	0.8
Paper Mills	156,000	0.7	171,000	0.7
Collieries and wastage	2,208,000	10.2	1,220,000	5.3
Other forms of Ind. & domestic consumption	2,085,000	9.7	3,712,000	16.2
Total	21,706,000	100.0	22,842,000	100.0

2. Total Reserves of Coal classified.

According to the Geological Survey of India, coal reserves of different varieties up to one foot thickness of seams and within

1,000ft. is 60,000 million tons, found to be mostly in the Gondwana Basin The total workable coal is estimated to be 20,000 million tons.

Of these the coking coal, which alone at present can be used for iron smelting is only 15,000 million tons, within 2000 ft. of the ground surface.

I

DR. FOX'S BOOK

Total Coal Reserves.

1. Darjeeling and Eastern Himalayan region ...	100	million	tons
2. Giridih, Deogarh and Rajmahal Hills...	250	„	„
3. Raniganj, Jharia, Bokaro and the Karanpura Fields ...	25,650	„	„
4. Son Valley—Auranga to Umaria and Sohagpur ...	10,000	„	„
5. Chhattisgarh and Mahanadi (Talcher)	5,000	„	„
6. Satpura Region–Mohpani to Kanhan and Pench Valley ...	1,000	„	„
7. Wardha Godavari–Warora to Bedadanuru ...	18,000	„	„
...	60,000	„	„

II

Reserves of Workable Coal

1. Darjeeling foot hills Lisu-Ramthi Area	...	20	million tons
2. Giridih, Jainti and Rajmahal Hills	...	80	„ „
3. Raniganj, Jharia, Bokaro and Karanpura fields	...	10,150	„ „
4. Son Valley–Huttar to Umaria and Sohagypur	...	2,000	„ „
5. Chhattisgarh and Mahanadi (Talcher)		1,200	„ „
6. Satpura region–Mohpani to Kanahan and Pench	...	150	„ „
7. Wardha-Godavari Warora to beyond Singareni	...	6400	„ „
* Total	...	20,000	million tons

III

Reserves of good quality coal (both coking and non-coking)

1. Giridih and Jainti	...	40	million tons
2. Raniganj	...	1,800	„ „
3. Jharia	...	1,250	„ „
4. Bokaro	...	800	„ „
5. Naranpura (North and South)	...	750	„ „
6. Hutar, Johilla, Burhar	...	50	„ „
7. Kurasia, Jhilimili, etc.	...	30	„ „
8. Talcher to Korba	...	200	„ „
9. Mohpani, Kanhan-Pench	...	30	„ „
10. Ballalpur–Singareni	...	50	„ „
* Total	...	5,000	million tons
Coking coal	...	1,500	million tons
Non-Coking coal	...	3,500	million tons

* These are now appreciably low

The total good quality coal, excluding the coking coal which can be profitably used for conversion into liquid fuel is, only 3500 million tons. The coal reserves of India, so far as it is known, are very small compared to U.S.A., U.S.S.R., England, Germany, even to Japan, and quite insufficient for a big country like India.

3. Remarks on Consumption of Coal.

(a) Misuse of Coking Coal.

The coking coal, which ought to be exclusively reserved for smelting purposes is now being mostly used for other purposes. In 1935, 11.5 million tons of coking coal were raised and only 2.5 million tons were used for smelting. The rest was used for purposes which could be served by other varieties of coal. It is feared that this sort of misuse will continue unless it is stopped by the Government.

According to the findings of the Coal Mining Committee, (1937) the entire known reserves of coking coal will be depleted in about 60 years, after which the metallurgical industries will be faced with a serious situation; for though India has got iron ore of very good quality in enormous quantities, she possesses proportionately less of coking coal required for its conversion to pig iron which is the basic material for all machineries At the present rate of wastage of coking coal, after about sixty years, the iron-smelting industries would come to a standstill, unless some technical process is discovered by which iron ores can be worked by other varieties of coal. India will then be forced to export her ores just as Sweden does at present, because though she has the best ores, she has practically no coal for smelting the ores.

(b) Misuse of Superior Grade Coal.

At present most of the coal raised is of good quality (20 million tons in 1936 out of 23 million tons). At this rate, according to the findings of the Coal Mining Committee, 1937, the good quality coal will be exhausted in about 120 years provided the recovery is 50%.

The superior coal should be reserved for such purpose as hydrogenation of coal to liquid fuel, as well as for blending, importance of which is stressed later.

(c) Improper and inefficient Utilisation of Coal.

In this country coal raised from the mines is stored and handled in a wasteful way, and is consumed mostly in the raw state, without any prior processing according to the needs of the consumer. The little processing which is done by the coal-processing industries (e.g. manufacture of hard and soft coke) is wasteful from the point of view of recovery of valuable by-products such as tar-products, ammonium compounds, gas (in the case of soft coke).

We recommend :—

(1) The recovery of the by-products—gas and tar—produced in the manufacture of "soft coke". It has been estimated that, on the most conservative basis in the Jharia coal fields alone, some 30 million gallons of tar, comparatively rich in motor spirit, light oils and other substances are being wasted every year. As the "soft coke" industry is confined within the restricted area of the Jharia and Raniganj coal fields, every "soft coke" manufacturer should be under statutory obligation to recover the tar for further treatment in a Central tar distillation plant working under State control. (See also under ' Liquid Fuels ').

(2) It is well-known that some of our inferior grade coals, considered unsatisfactory for steam raising in the usual manner, can become quite good for this purpose if made into pulverised fuel. The fusibility of the ash is the most important determining factor in this connection ; and a systematic investigation into the grading of II class coals on the basis of the fusibility of their ash, may result in the use of those coals with non-fusible ash for steam-raising purposes, thus conserving the high grade coal. The washing of coal has been extensively adopted in other countries to improve the quality and quantity of coal ash in lower grade coals.

(3) Some of II grade coals are also considered unsuitable for ' soft coke ' making, as they do not give the light and spongy

structure to the coke, necessary for easy burning. If by suitable treatment in the process of coking this object is achieved, it would find an important outlet for some of these coals for which at present there is poor demand, and release a certain portion of the better grade coal, now converted into soft coke.

4. Defects in mining methods.

It has been established beyond doubt by the findings of several committees such as the Coalfields Committee, 1920, the Coal Mining Committee, 1937, and some independent authorities (Drs. Fermor and Fox, Mr. R. R. Simpson, Chief Inspector of Mines, Prof. S. K. Roy and several others) that the Indian collieries are responsible for the following practices which cause loss of valuable and irreplaceable national property

(a) Too much extraction in first working (weakening or thinning of supporting pillars with consequential collapses, fire, flooding.)

(b) That the mining operations are often conducted in ways which may be cheap, but involve a considerable loss of coal; and not much care is taken in planning the underground workings.

(c) That in many collieries there is a practice of rotational working, i. e. extraction of superior coal seams before the extraction of upper seams which may be a little inferior without adopting adequate measures for protection of the upper seams, such as sand stowing. This bad practice which is adopted mainly for profit purposes has resulted in heavy losses of good coal in Jharia and Raniganj, caused by the subsidence of the overhanging seams.

(d) A large amount of coal is buried under railways, roads and rivers and steps should be taken for their working.

5. Position of Landlords.

It has been shown that for the wastage in mines, the land lords are largely responsible, for they do not exercise control which is expected of them, on the colliery owners. For immediate financial gain they lease out coal areas which are not economic, they do not take action against colliery owners who

abandon mines on account of fire, subsidence or for reasons of economy, and even when they have been compensated for their own share of the Royalty, which barely amounts to a fraction of the intrinsic property of the coal, they allow valuable national property to be permanently wasted.

6. Causes of Continuance of Defective Methods in mining handling and utilisation:—

The absence of any substantial control on mining, handling and utilisation causes very serious losses to a valuable national property, and one unacquainted with the conditions of India's coal mining industry is surprised why such a wasteful system is continued. This is mainly because the value of coal to national life has not been recognised in this country, and coal is not regarded yet as a national property.

The colliery owners are mainly guided by profit motive, and in the absence of control, have adopted and have been continuing wasteful methods in mining, handling and storage, because they are cheap, and enable them to market coal in an uncontrolled market at a competitive price. It has attracted a far larger amount of capital on account of the prospect of ready gain, and the industry has been in a state of chronic depression on account of lack of organisation amongst colliery owners, leading very often to over production, cut-throat competition, decrease in price for which the State, being one of the principal producer-consumers, is also responsible. A big producer consumer, when allowed to offer tender for his own purchase, can always turn the situation in his favour, even though producing that commodity at a higher cost. This has been the case with Indian Railways.

Moreover, prices of coal in this country, which are rather low in comparison to that in Europe and America, have delayed any voluntary attempts to increase the efficiency of utilization—being not worth the salt. From these considerations we recommend, therefore, that early steps should be taken to ensure an economic stability to the coal industry which is a prerequisite to conservation.

7. Case for State-Control.

The above analysis shows that an irreplaceable and invaluable national property is being wasted. The complications are such that the only body which can take efficient steps for the safeguarding of this valuable public property is the State; but we have shown that it has refrained from taking any serious action in spite of the recommendations of its own committees and experts, the chief plea being that the State cannot intervene and infringe the rights of permanently settled Zamindars in Bihar and Bengal. Even in C.P., where the mineral rights are owned by the State, no action has been taken for the prevention of waste by the colliery owners.

But in no other countries is such wastage tolerated; some kind of control is invariably exercised over the whole range of operations from mining to consumption.

8. The Principles guiding State Control:

We are of opinion that the State should exercise strict control over the coal industry for the following reasons:—

(a) Coal is a valuable and unreplaceable commodity which is regarded as a national property in all countries.

(b) It is one of the chief sources of power, the basic material for transport and industries; and its importance to India is all the greater on account of scanty resources of oil in India.

(c) With the coal industry is associated the prosperity of the iron and steel industry—one of the key industries.

(d) It is one of the important raw materials for synthetic chemical industries (dyes, drugs, antiseptics, etc.)

(e) With the prosperity of the coal industry, is linked up the welfare of a large number of people engaged in coal mining

(f) The control will bring about economic stability to the coal industry, which is one of the indispensable steps in reducing waste in mining. So long as coal mining is carried on in a state of chronic depression, little progress in reducing the present wastes can be hoped for even in the face of statutory regulations. It can at the utmost result in increasing the number of abandoned mines.

9. Position with respect to Liquid Fuel:

Liquid fuel (Petrol, Kerosene, Diesel oils and Lubricating oils) holds a key position for defence, transport and industries, and every selfcontained region of the world should have a definite policy with respect to this Commodity.

India consumed, according to Dr. N. G. Chatterji, in 1937–38, 326 million gallons of liquid fuel of all kinds of total value of nearly ten crores of rupees, of which only 76 million gallons are produced in this country, chiefly at Assam, and at Attock by two big English Companies. The consumption of liquid fuel per head in India is less than a gallon per head per year, which figure may be compared to 50 gallons per head in U. S. S. R., 25 in the United Kingdom. With the growth of industries and improvement of roadway, as contemplated by the N. P. C., the demand for liquid fuel is bound to go up five or six times its present figure, requiring either the import or manufacture of fuel to the extent of 60 crores of rupees.

Unfortunately so far as is known at the present time, the sources of petroleum in India appear to be very limited, especially after the separation of Burma.* Our impression is that prospecting for oil with modern geophysical methods has not been seriously undertaken in the continent of India by the Government. Most of the work in this connection has been done by the big Oil Combines (Burma, Assam, and Attock Oil Companies); but their findings are unknown to the public. There are, however, reasons to suspect that oil fields may be hidden under the earth's crust in some other parts of India, as prospecting licenses are understood to have been secured by some non-Indian financial syndicates.

Whatever that be, the present situation is that our mineral oil resources are very poor, and with the growing importance of liquid fuels, it is imperative that all available indigenous sources for other kinds of fuels to take the place of petroleum must be developed on a carefully planned national basis.

Almost in every country where the indigenous petroleum resources are poor or entirely absent, attempts to make sub-

* And now, after the separation of the Punjab, the limitation will be still further increased — Editor.

stitute liquid fuels have been directed mainly in the two following directions:—

1. The processing of coal by different methods so as to produce liquid fuels. Of these methods those that have been commercially tried with some success in Europe are :—

a Hydrogenation of low temperature tar and in some cases coal as such (Bergivs process)

b The synthesis of liquid hydrocarbons (liquid fuels) from the gases evolved during the gasification of coal. (Fischer-Tropsch process).

c Carbonisation of coal at temperatures lower than those used in high temperature carbonisation for gas and coke works, and

II The utilization of agricultural products for conversion of the starchy or sugar materials, contained therein to alcohol.

Apart from the highly technical questions involed in the 'liquefication of coal' processes, large scale operations require huge outlay in capital expenditure, at any rate in the case of (a) and (b). Moreover it is very doubtful if liquid fuels would ever be made in this way at a rate cheaper than the natural imported products, so that these processes may for the present be left out of consideration.

The third process , namely the low temperature carbonisation of coal, however, deserves serious attention in this country , particularly in view of the encouraging results obtained from the trial run of a pilot plant installed in Bihar and worked according to the instructions of Dr.H.K. Sen of Ranchi. It has been previously mentioned that the present practice of making soft coke without the necessary byproducts is extremely wasteful; and on a conservative estimate, the following quantities of the various byproducts obtainable from the tar may be recovered per annum.

Motor Spirit	0.75	million gallons.
Kerosene type	1.50	million gallons.
Fuel Oil	3.00	million gallons.
Creosote Oil	0.75	million gallons.
Ammonium Sulphate	10,500	tons.
Residual Pitch	15,000	tons.

We, therefore, recommend that the soft coke industry be so reorganised as to make it obligatory for the makers to recover the crude tar to be further processed in a Central tar distillation plant, under State control. With this object in view, research work should, if necessary, be at once undertaken, the expenses being met from the Soft Coke Cess.

Alcohol is the most important liquid fuel that can be produced to an almost unlimited extent in agricultural countries. Practically every country in the world without indigenous petroleum resources has concentrated on the production of alcohol as the most important alternative fuel for internal combustion engines. Col. Sir Frederick L. Nathan carried out a survey of the potentialities of the alcohol resources of the British Empire.

A fairly exhaustive investigation of the possibilities of alcohol manufacture with special reference to the U. P. and Bihar has been published in the Report of the Joint Power Alcohol and Molasses Inquiry Committee (Bihar & U.P.) 1938. The most important matter of interest in this respect is the conclusion that, at least in the above mentioned two provinces, power alcohol can be marketed at substantially the same price as petrol.

It is estimated that about 15 million gallons of power alcohol can be produced from surplus molasses, for which there is at present no market. The other important source of alcohol is *mahua* flower, which is available almost in every part of India and is largely used for alcohol manufacture. It is estimated that some 3.5 million gallons of alcohol can be made every year with the flowers obtainable from the existing trees. The plantation of *mahua* trees can easily be extended, as the tree is popular in rural areas on account of its seed, which is a readily marketable commodity.

However, the world's production of power alcohol is at the present time perhaps more from starchy materials like grains and potato than from sugar-containing substances. In view of the fact that in India we have an almost infinitely expandable source of cheap starchy materials, the potential resources of alcohol are

practically inexhaustible. On this account, coupled with the fact that alcohol is an agricultural product, it is a matter of utmost national importance that India should concentrate on replacing the use of mineral oils by alcohol. It is estimated that, if an all-round increase of only 5% in the production of cereals and grains be brought about and reserved for the distilleries, the latter would be able to supply the country with about 45 million gallons of alcohol, —a quantity which is more than one-half of the total mineral oil production in India. Our recommendations are:-

(1) That the Government of India should establish a Geophysical Prospecting Department with modern equipment and competent staff and carry on an intensive search for petroleum sources in the country. Further, that prospecting licenses should not be issued to foreign companies unless their operations are under strict State Control. This may form part of the Central Mineral Research Institute, or of the proposed National Physical Laboratory.

(2) All restrictions — legal and economic — likely to impede the development of the power alcohol industry, should be removed. For example, excise rules should be made more liberal; and the excise duties charged on petroleum products and alcohol fuels should be adjusted on the basis of national interests and economy and not merely on gross State revenue.

(3) Intensive propaganda work should be started to replace kerosene by non-edible vegetable oils, and alcohol for lighting purposes, especially in rural areas.

(4) Alcohol being the most important liquid fuel which can be developed easily with indigenous agricultural products, the power alcohol industry should be organised and developed on an all-India basis under State Control. The policy adopted in most countries is to have the manufacture done by private persons, but the distribution, fixation of price and sales, done by a State or semi-state organisation.

(5) A new orientation to the scheme of Soft Coke Manufacture should be given by making it obligatory for all to

recover the byproduct, tar, for the purpose of its further treatment in a Central Distillation plant. In the meantime, funds should be allotted from the Soft Coke Cess for the purpose of carrying on researches with this object in view.

Need for a National Fuel Policy.

We have considered the question of fuels in general from the standpoint of present and future welfare of the country and suggested measures. If these are to be given effect to, the first necessity for the State would be to clearly define a National Fuel Policy which will act as a guide for the activities of the State in this direction at present and in future.

The guiding principle in laying down a National Fuel Policy should be the interest of the nation as a whole, which should be supreme and should not be allowed to be subordinated to commercial interests. The central idea should be that for every major use, such as for the consumption of fuel by railways, the iron and steel industry should be determined, considering its present and future availability. No fuel, however inferior and small, should be allowed to be wasted and there should be no misuse of any fuel. Efforts should be made for the discovery and production of substitutes of those fuels, e. g. petrol, for which the country has to depend on imports and whose supplie during times of emergency may be cut off and consequently threaten the welfare and defence of the country. All legal difficulties which stand in the way of the National Fuel Policy should be removed. We wish to invite attention to a step which should be immediately taken.

(a) Nationalisation of Mineral and Fuel Rights.

The first step towards state control should be that the State should own all rights over coal properties, as is the case in France, certain parts of Canada and Germany, and has been proposed to be done in England.* The State can then force small collieries to amalgamate, carry on planned mining on an economic and efficient scale, and take steps for prevention of subsidence and extinguishing of fires and abandonment of mines

* It has now been done — *Editor.*

The output of coal can be regulated according to the needs of industry and transport.

The opening of new small and uneconomic collieries which, has been very common in India during boom periods due to ease of getting leases, and has not only brought about chronic depression in the industry, but has caused a heavy loss of coal property by their unsystematic working and early abandonment, can be efficiently stopped.

The irregular boundaries, as a result of which much of coal cannot be extracted, and is usually lost, can be properly adjusted to ensure safe and economic extraction of coal.

Fuel Board.

If the measures discussed in these reports are to be given effect to, the State should set up an organisation under the Power and Fuel Commission to be called the Fuel Board. This body will be the central authority responsible for all types of fuels in all their aspects, i.e. production, processing and utilisation and distribution, transport etc. There will be three committees under this body.

1. Fuel Production Committee.
2. Fuel Processing and Utilisation Committee.
3. Fuel Distribution, Marketing and Transport Committee.

The functions of each of these bodies are briefly summarised below:—

1. **Fuel Production Committee.**

The duties of this Committee will be to direct and supervise the operations of surveying, prospecting, mining, handling and storing of fuels — coal, lignite, peat, shales, petroleum, natural gas, etc.

It should work in two sections : (a) Surveying and Prospecting, and (b) Mining, Handling and Storing.

(a) Surveying and Prospecting.

Surveying and prospecting for fuels have so far been carried out by the Geological Survey of India, whose results are

available in the publications of the Survey, and by private parties who always keep the results to themselves. The duty of this Committee would be to control these operations in the interest of the nation, though we are unable to prescribe the exact form of the control at present. We wish to point out that prospecting with modern appliances has been neglected in India. This work should be started by the Committee.

(b) **The Mining Section.**

The duties of this section should be to advise the Government on the introduction of the latest methods of mining, consistent with efficiency and safety; it will investigate the causes of accidents and recommend measures for safety; it will inspect and supervise all mining, handling and storage operations, with a view to ensuring the proper execution of mining rules and regulations. The present Mines Department is in charge of this work, but so far it has been concerned only with the safety of workers. The efficient working of the mines is mostly left to the owners, but as pointed out, this should be controlled.

2. Fuel Processing and Utilisation Committee.

The main functions of this Committee would be to ensure the proper and economic utilisation of fuels, which has been discussed in S. 8 and to direct work on the production of these fuels (e.g. liquid) which are not available in this country. In this respect, the functions are similar to those of the Fuel Research Board in England. For this purpose there ought to be established a number of Fuel Research Stations under the control of this Committee whose functions will be both research and train ing. It will be necessary to equip the stations with semi-commercial plants, so that their results may be of practical use and command confidence of the industrialists. The research stations should also afford facilities to the technical staff working in factories to work part-time in their laboratories on the fuel problem. It is essential that there should be complete co-operation between all the fuel consuming and processing industries and this Committee.

3. Fuel Distribution, Marketing and Transport Committee

The duties of this Committee will be to bring about economic stability to the coal industry (vide S.8) and prevent misuse of fuel (vide S.3). In collaboration with the Fuel Processing and Utilisation Committee, it will decide which fuel will be more suitable to a particular consumer. For this purpose it should set up a Coal Marketing Organisation under Government control, the members of which will consist of both producers and consumers.

It will have to recommend a suitable freight policy for the transport of fuels. It will be responsible for the export and import policy of fuel, and should be consulted by the Tariff Board in shaping their policy with respect to fuel. The present Coal Grading Board should be under the supervision of this body. It should maintain a very efficient Statistics Department, which will not only keep proper statistics of fuel production and consumption in this country, but will also maintain relevant data on other countries.

We may remark in this conection that the National Institute of Sciences (India) at a recent meeting held in August 1939, passed a resolution recommending to the Government. to establish a Fuel Research Board.*

POWER

1. Total production of Electrical Energy in India.

The Economic Adviser to the Government of India has just started collection of statistics of electrical energy generated and sold in British India. It does not take into account the electric energy generated and sold in the Indian States. Even in British India, the electrical energy generated and sold by the Public Works Departments and the Military stations in British India has not been taken into account. According to these statistics, the total electrical energy generated in British

*The Government of India Activity during War:--

(1) Sand-stowing Act

(2) Decision of C. S. I. R. to establish a Fuel Research Station.

(3) A Coal Commission for distribution of Coal has been appointed by the Government of India.

India by non-Governmental supply undertakings in 1938–39 was 2,004,418,000 units.*

Figures relating to the production of electrical energy in Mysore, in the regions served by the U.P. Ganges Canal, H.E. Scheme and the Punjab Uhl river H.E. Scheme should be added to the above figures. These figures for the three areas are as follows for 1938–1939.

Mysore	...	255,000,000	units generated
Uhl River H.E. Scheme	...	60,000,000	„ „
U.P. Ganges Canal H.E. Scheme	...	49,337,508	„ „
Total for all other Native States and Government undertakings in British India other than those mentioned above.	...	50,000,000	„ „
		414,337,508	„ „

This brings the total number of electrical units generated in India, taken as a whole, to approximately 2,418, 800,000 K.W.H.

2. Per capita Production compared to other Countries.

Since the last war it has been the practice in every civilised country to keep statistics of the total amount of electrical energy produced and consumed from different sources (e.g. Hydro-electric, thermal or from oil) because such figures convey, as no other figures do, in a very vivid way the industrial progress of the country. All these figures are collected and published in a tabular form by the League of Nations. But as far as India is concerned no figures are to be found in the League of Nations Year Book, presumably because the Government of India had not supplied them with any figures. Such figures for certain representative countries are given below in a tabular form.

* According to *Public Electricity Supply All-India Statistics, 1944*, the total KW. generated in 1944 was 3841.3 millions.

Production of Electricity in Different Countries (1938)

Country	Units generated Million KWH	Increase in last 10 years	Units generated per capat
Canada	25,999	8,000	2320
Switzerland	7,043	1,743	1688
Sweden	8,150	3,183	1300
U. S. A.	141,000	20,000	1090
Germany	55,238	24,577	738
U. K.	30,700	14,894	648
S. Africa	5,336	—	544
Japan	26,714	13,402	374
U.S.S.R	36,400	30,176	215
Mexico	2,506	1,042	130
India	3,400	—	8.8

3. Energy Production from all Sources.

It is very difficult to estimate the total energy produced from all other sources–human, animal, steam and petrol, wood baggasse and other combustible matter. But the total cannot be more than 100 units per capita per year. It is nearly 15 times less than the standard for civilised countries.

***4.* Hydro-electric development Indispenable for Indian Industrial Development.**

Electricity can be produced either from coal or from water-power. There is a general belief that electricity from water-power is cheaper than that produced from coal because in that case nothing is spent on fuel. This is, however, entirely misleading, because the cost of fuel is only one of the items of expenditure in a thermal power station; e.g. for a unit of electricity produced in Calcutta the expenses under the different headings are as follows:—

(1)	(2)	(3)	(4) Total working Cost per Unit Generated.						
STATION	Motive Power	Units Generated	(*a*) Fuel in annas	(*b*) Oil waste, water, Engine room Stores.	(*c*) Wages and salaries exclud-ing manage ment.	(*d*) Re-pairs and Main-tenance	(*e*) Rents, Rates, and Fare.	(*f*) Mana-gement, Directors' fees, Sala-ries, Office and Legal expenses	Total
Calcutta Electric Supply Corporation	Steam.	280.6	.090	.002	.057	.085	.014	.164	.412
Karachi	Oil	6.2	.269	.044	.167	.422	.030	1.213	2 145
Lahore	Steam	13.0	.277	.007	.073	.217	.008	.216	.798
Cawnpore.	Steam	88.3	.125	.002	.014	.050	.002	.07	.270
Tata Hydro Eelectric.	Water	163.4	—	.011	.043	.005	.010	.264	.333
Andhra Valley.	Water	159.9	—	.005	.038	.007	.009	.383	.441
Tata Power Company.	Water	161.8	—	.005	.040	.001	.013	.424	.483
Shivasamudram	—	—	—	—	—	—	—	—	.164as.

It will be seen from the above statement that fuel forms less than 5% of the total expenses. This is because coal is rather cheap at Calcutta (about Rs. 6/- per ton); but in up-country stations which are far removed from coal fields, e. g. Lahore or Bombay, long haul coal has to be used and the expenditure under the heading goes up three or four times. At Lahore, for example, it sells at Rs. 20/- per ton and the charges for fuel per unit come up to, ·277 annas per unit in 1931.

Twenty five years ago expenses on fuel were much larger; but on account of improvements in boilers and steam turbines it is now possible to produce four times the energy from the same amount of coal. In England one unit is obtained from 0. 9 lbs. of coal at Battersea and in other less efficient stations one unit does not require more than 1. 5 lbs. of coal. In India it requires on the average 1. 5 lbs. of coal for a unit of electricity. Twenty five years ago the cost of one unit of electricity from thermal stations was very high and hydro-electric stations compared very favourably with them. But now the tables have been turned. It has now been found that hydro-electric stations are much more costly on account of a large amount of initial capital which has to be spent in construction, e. g. dams, reservoirs and transmission lines. It is well-known that even in far-famed hydro-electric works at Niaworks at Niagra Falls,thermal stations sprung up which offered electricity much cheaper than the hydro-electric company, so that the latter was compelled to buy up the thermal stations and form a Trust. This point is dwelt in detail here because hydro-electric stations are bound up in the public mind with the idea of getting power out of nothing and has been utilised by unscrupulous and mis-informed people to exploit public finances. India has got her sad tale to relate in this matter. The notorious UHL river scheme, of which we speak later, is a glaring instance. If one works up the interest on the entire capital sunk therein [In the official account the expenditure has been distributed under different heads, and only a fraction of the total expenditure has been charged to the hydro-electric scheme.] the price per unit offered by this ill-started enterprise would go up to as much as As.-/6/-. In the Ganges Canal

Hydro-electric Scheme the price of one unit of electricity comes up to 0. 89 of an anna, while the price of a unit made by the thermal stations in the very same region came nearly to half, i. e. 0. 4 of an anna. These instances are quoted just to warn the public against running mad with the idea of hydro-electric stations.

The instances given are of gross official mismanagement; and it must not be supposed that all hydroelectric enterprises in India have been as inefficient as these institutions. Such schemes as work in Mysore, Madras and Bombay have been financially successful, though even in them there was much scope for improvement.

In spite of what has been said above large tracts of India must ultimately depend upon the development of water-power resources for the running of their industries. Although from the point of view of individuals interested in power supply, it would be only under particularly favourable conditions that the production cost per K.W.H. generated by water power can compete with the cost per K.W.H. generated by modern steam power plants, the erection of water power plants is, however generally justified from social considerations.

In India the coal resources are not bountiful. The problem of conservation of power resources looms large in the national planning. This national policy of conservation can be promoted by the establishment of a system of social accounting in which items of national concern that do not appear in the books of private enterprise are given due weight. As for example electric power may be derived from coal or oil. It should be enquired which is the cheapest and most efficient source for any particular type of use. It must also be enquired whether the use of a self-replacing resource like water power is not on general grounds preferable to the use of a wasting resource like coal, if a charge for national depletion be included in the calculation. The production of power is only one use to which each of these resources may be put. The cost of and demand for these bye-products must, in a rational calculation, affect the choice as to the source of power. In the words of President

Franklin Roosevelt – "To make such an evaluation, a higher form of accounting than any yet developed by commerce and industry appears to be essential. It must be a form of accounting that takes social values, now left to mere assumption, into calculation and measure them.If a Nation were to establish in its social balance-sheet a capital account for its energy assets and were to charge against that account the water that it permits to go unused, as well as the coal and the oil that are used, then perhaps all citizens would perceive that public policy and private conduct in respect of our natural resources should be quite different from what they now are.".

Water power used for electric generation is closely linked with flood control, soil conservation, navigation, irrigation afforestation etc. At places it comes out almost as a by-product. In the U.SA. several of the big hydro-electric projects were not built for getting power, but for some other purposes, e.g navigation, irrigation, flood control, etc., and power came out as a by-product. The best example of such multipurpose development of waterways is afforded by the Tennessee Valley Reclamation Scheme.

Every cubic meter of water running to waste means a loss to national wealth. As a way to absorb otherwise unproductive labour (of which there is always a plenty in this country) during periods of unemployment, hydro-electric and other water development projects give much promise. Even though such a development can be achieved only over long periods, and at low interest rates, they may represent a clear saving ever what would otherwise be a waste of human resources, and would, therefore, constitute sound public investment.

A well chosen and well built water power is exceptionally enduring. A hydropower will, therefore, generate current at very low rates once the capital, investment is written off*. We

* Perhaps the greatest source of deterioration is the silting of reservoirs Carefully controlled measurements at the Norris Dam of the Tennessee Valley Authority in the U. S. A. indicate that, even at the present rate of erosion on the watershed, the "dead Storage"below the power house intake will not be filled with silt for 500 years and the reservoir will become half-filled with silt in about 1700 years. On the other hand some very small

see from these social considerations that hydroelectric power appears to hold out big promises in this country; but it will have to be done properly. The first requisite for the proper development of water power resources of this country is their adequate survey. Such a survey does not exist here except some preliminary work of the now defunct, Hydro-electric Survey of India which had its origin in the recommendations of the Indian Industrial Commission of 1918. It was very inadequately staffed with engineers having a knowledge of general P. W. D. and irrigation work† and having no proper training in H. E. Survey. Mr. J. W. Mears, the Director of that Survey (Para 55, P. 53 of Vol. III of the triennial report of the H.E. Survey of India by J.W. Mears) stated that the survey so carried out was nothing better than an intelligent guess work. Such a survey is not only insufficient, but it is absolutely unreliable. In spite of the frank admission of Mr. Mears,* this survey had been used as a reference in all susbsquent works, sometimes with unhappy results. Further, some electrical engineers are under the erroneous impression that this survey has given us sufficiently correct data for starting an enterprise. That such an idea may be entirely misleading is afforded by the parallel case of Russia. In 1916 (i.e. during the Czarist regime) the Russian Ministry of Agriculture estimated the total waterpower resources of the country at 14,600,000 K.W. (fourteen million); at the first World Power Conference in 1924 Soviet waterpower resources were estimated at 47,700,000 K.W; while at the beginning

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water power reservoirs have been half-filled in ten years. As greater progress is made in promoting proper land use and regulation of head water streams, it is reasonable to expect that the problem of sedimentation will become very much less important than it is at the present time. Afforestation of the basin, and providing it with grass cover has been found very beneficial against silting.

†Mr. J. W. Mears writes in the very first paragraph of his introduction to Vol III of the triennial report of the Hydroelectric Survey of India as follows;-- "..... the officers in charge of the survey in the provinces have had, for the most part, no previous experience of the specialised problem of water-power; and dealing with most immense areas, their subordinate staffs have necessarily had to work largely on their own initiative, with no text-books other than the earlier reports".

of 1935, when more scientific, accurate and extensive surveys had been carried out, the proved water-power resources of the country's rivers (comprising about 70% of all the rivers in the Soviet Union) were found to total 280,000,000 K.W. for stream flow available 50% of the time. In other words, adequate and proper survey revealed that the power resources were about twenty times higher than the first estimate based on mere guess work.

Surveys have, in the meantime, been carried out by some Provincial Governments and States; but except in one or two cases they do not come up to the standard of Canada, Italy Soviet Russia, etc. In this country there is a great deal of ignorance about the proper method of carrying out hydro-electric survey. Some idea about the proper scientific organisation of countrywide hydro-electric survey may be obtained from the case of Canada, which stands at the head of nations developing the maximum amount of electrical power per capita. The account is taken from a paper by the Dominion Water Power and Hydro-metric Bureau of Canada published in Vol. VII of the Transactions of the Third World Power Conference. Washington, 1936.

Hydro-electric and connected Survey in Canada

Canada, in consequence of systematically directed effort on the part of the Dominion and Provincial Governments, extended over a period of many years, is in the main, well equipped with physical data upon which to plan the utilisation of its water resources. Orderly investigations in field and office have been made from year to year by the Dominion and by the Provinces, each in its own field, and in cooperation with the other.

Climatological data

Climatological data is collected and compiled by the Meteorological Service of Canada, with head office in Toronto; this service is under the Department of Marine.

The Meterological Service has established some 860 Stations throughout the Dominion designed to cover the country as completely as settlement conditions will permit, and

to secure a systematic and dependable record of meteorological conditions from coast to coast. The stations are grouped into various classes ranging from " Chief Stations ", where all the principal elements are automatically registered, being chcked by eye readings at certain stated times daily, down to class III stations, where precipitation only is measured and recorded*.

As a result of these efforts a very complete record of meteorological data covering the Dominion is available for reference as and when required.

Hydrometric data

In Canada the term 'hydrographic' is reserved to the investigations of the Department of Marine in connection with the surveys and preparation of charts for navigation Water supply investigations are in the main carried out by the Dominion Hydrometric Survey.

The Dominion Hydrometric Survey may be said to have been established as such in 1920, under the Dominion Water Power and Hydrometric Bureau of the Department of the Interior. Subsequently there has been a gradual absorption of local or special stream-measurement studies previously carried on by other organisations Special studies are manintained by the Departments of Marine and of Railways and Canals.

The Survey has established a widespread series of stations throughout the Dominion designed to cover the important rivers and streams. It works in co-operation with the Provincial authorities in the securing of the records required for both Dominion and Provincial administrative purposes, and for the overall analysis of hydraulic problems from coast to coast.

The hydrometric Survey is organised with district offices in Vancouver, Calgary, Winnipeg, Ottawa, Montreal and Halifax. Valuable co-operation is received not only from the Provincial Governments, but also from municipal corporations

* In India the meteorological service is very well organised and it has a large number of stations all over the country. Only the data have not been utilised for hydrometric purpose.

and other interests concerned in the obtaining and use of water supply data.

Stream-measurement data are worked up and assembled in the district offices, and then forwarded to the head office for publication as a water-resources paper. These papers are issued by main drainage-basin divisions. These papers are published annually or biennially, as is most convenient and cover a climatic year from October 1 to September 30.

As a result of past and continuing efforts, a very complete record of run-off data covering the Dominion's river systems is available for reference as and when required.

Topographic data

The issuance of maps, geographical and topographical, is by three different departments of the Dominion Government–Interior, National Defence, and Mines. The topographical and Air Survey Bureau of the Interior Department, which is the major mapping organisation, is responsible for the National Topographic Survey, and the general geographical maps. It is the centralised office for all air surveys.

The Geographical Section, General Staff, Department of National Defence, confines itself mainly to 1-mile to 1-inch topographical maps of southern Ontario and Quebec, together with compilations from them 4-2-,4, and 8-miles-to-1-inch, all of which are being made conformable to the National Topographic Series. It does a limited amount of topographic mapping of special areas at the scale of 1 to 25,000. It is also a self-contained unit printing its own maps. The Royal Canadian Air Force of the same department does the great bulk of air photography which is used for mapping. *

The Geological Survey of the Department of Mines has played a very important part in the exploration survey and mapping of Canada. The Topographical Division of the Geological Survey is, however, definitely organised for the

*Such maps are being prepared in India by the Trigonometric Survey, which is a well organised department of the India Government.

execution of Survey work, and makes topographic maps of different parts of the country usually at the 1-mile scale; where it is demanded for the purpose of geology or mining, maps are made at larger scales.

The Geodetic Survey of Canada of the Interior Department executes all work of that nature undertaken in the Dominion, together with the precise levelling. The lines of precise levelling have been extended from ocean to ocean and in general, cover all the main railway lines.

Dominion Water Resources Index-Inventory

The Dominion Water Power and Hydrometric Bureau of the Department of the Interior maintains a Water Resources Index-Inventory for the recording, collating and analysing of the water resources data of the Dominion.

The inventory has been developed upon the basis of the natural drainage-basin areas, the Dominion being divided into 11 numerical major division; and these being alphabetically sub-divided and sub-divided to the extent necessary to provide suitable reference areas for the recording of hydro data under suitable topic headings.

Under the Index inventory, the water-resources data accumulated in the district offices by direct field work, and through co-operative effort with provincial and local authorities or interests, are transmitted to the head office in Ottawa; where they are co-ordinated, compiled and analysed in accordance with the principles of the inventory.

All available data with respect to developed and undeveloped power and storage-reservoir sites are collated, studied and summarised, and digests of the individual sites are prepared covering location, accessibility, head water supply, storage capacity, regulation of flow, possible power, hydro-power installation, use of power, municipalities served, market and sources of data. Summaries of the power and water resources of rivers and river systems as a whole are similarly analysed and compiled.*

*In this connection the appalling conditions of the dearth of our knowledge about Indian rivers is given in the following passage due to Sir Francis Spring while designing the Hardinge Bridge at Sarch over the Ganges. Due to the inertia of the Government of India things have not changed to any appreciable extent. [Passage not given in the tet of the Report-*editor*].

Material thus compiled is immediately available for the analysis of the water resources in relation to industry, industrial centres, industrial opportunities, transportation systems, mineral resources, timber resources, coal and fuel supplies electrochemical and electro-metallurgical opportunities, irriga, tion, drainage, reclamation and water supply projects, alternative sources of power, uses of power in general and markets for power in general.

Water-supply data are available for analysis in relation to water power, storage, river regulation, domestic water supply, sewage disposal, irrigation, reclamation, drainage, navigation and other problems dependent for their solution upon water data.

By means of official publications, special reports, special memoranda, standard summarised reports on developed and undeveloped power and reservoir sites, and power rivers, by special analyses of particular problems, by correspondence and when necessary by referring to Provincial organisations charged with administrative responsibility, the data compiled in the Water Resources Inventory are transmitted to the public.

Hydraulic Research

Hydraulic research to date in Canada has been largely confined to facilities provided in the Universities with occasional studies of specific problems undertaken by the larger public and private hydro-undertakings in connection with their construction operations.

The larger Canadian universities possess hydraulic laboratories for instructional purposes in connection with their engineering courses. The equipment and apparatus which these aniversities have installed are intended primarily for student experiments on weirs, orifices, venturimeters, pipe lines and turbines and pumps. Since the main water-supply and measuring equipment are also the chief requirements in such other hydraulic research, these university laboratories have found, themselves able to undertake certain research work. A small part of this has been of the kind known as pure research, which

usually originates in the laboratory. The remainder has consisted of applied research, which is submitted from outside sources. At the present time, the amount of this latter class is small due to economic conditions. In the past, however, considerable work has been done on river flow, on hydro-electric power plant design and on hydraulic machinery. The results of this work have seldom been published because of their essentially private nature.

Recently the National Research Council of Canada has undertaken an inquiry into the question of the establishment of a hydraulic research laboratory to be operated on the Council's properties at Ottawa. The facilities available at this site are uniquely favourable.

U. S. S. R.

In the U.S.S.R., for example, the survey is carried out in an equally extensive scale. The Soviet Government, when it came to power, saw clearly that the social programme could not be carried out without a thorough going industrialisation; and as a first step towards the achievement of this object, they adopted a resolution decreeing the complete electrification of Russia. In pursuance of the resolution a hydroelectric survey was made on an extensive scale. As much as 35 million roubles were allocated to the Chief Power Board of Russia in 1933 for its river survey work. The Chief Power Board alone has established over one thousand stations for measuring the flow and level of rivers in the U. S. S. R. In 1935, there were 5200 hydrological stations (first, second and third class) maintained by the U. S. S. R. Hydrometeorological Service and 6000 meteorological stations (Second and third class). The Hydrological Survey is being carried out by the Central Bureau of Hydrological Survey. It does not deal with specific types of bodies of water (survey of rivers and lakes etc.) but includes all, the water of a given area (river, lakes, glaciers, ground-water seas). The whole Soviet Union has been divided into eighteen hydrological areas for this purpose.

The survey will consist, among other things, of a systematic card catalogue of information regarding the waters of the

U. S. S. R. The catalogue consists of eight series for each area; hydro-meteorology; dimensions of water areas; rivers lakes and ponds; swamps and marshes; ground waters, glaciers; and seas. Each series is further subdivided into three, sections; Hydrography, Stream-flow characteristics,and develop ment problems. The data contained in the catalogue will be used for the following purposes: (1) monographs on various bodies of water; (2) monographs on individual areas; and (3) a Hydrological Atlas of U. S. S. R.

During 1933-35 the Hydroelectric Designing Trust has been working on a series of water-power development outlines. These outlines fall into three groups, outlines of water-power resources, specific plans for the co-ordinated utilisation of water resources, and a concrete fifteen-year plan for hydro-electric development aiming at the development of the productive forces of the various areas of the U. S. S. R. The outlines give a survey of water-power resources that can actually be utilised from both the technical and the economic points of view.

Much has been done in the course of the first Five-year Plan in the Geological Study of river basins as a whole, as well as of particular sections of basins, especially by the Academy of Sciences, in collaboration with the Chief Geological Exploration Board. A number of topographical surveys have been carried out, and complete sets of maps and profiles are available for a number of rivers.

All the advanced countries of the world have been adopting similar methods for their hydroelectric and hydrometric survey work. We consider it superfluous to quote the various methods adopted therein. Reference can be made to them in the Transactions of the various World Power Conferences.

5. Power Development – the most vital factor in Industrialisation.

It is very imperfectly realised that power development is the most vital factor in industrialisation. Power is not to be produced simply for its own sake. It is to be produced so that it runs machines, gives heat and light, so that human drudgery

be alleviated, and goods needed for human consumption and use be produced cheaply and efficiently without tiring out human limbs.

The amount of ignorance and faulty information amongst the public regarding the part played by power in developing the countries' industries, transportation and national life in general is simply colossal. There is no doubt that in certain industries power is a small fraction in the total cost of the products. Their need for power is imperative; but they can carry on even if it is a little costly. There are, however, certain other industries in which cheap electricity is a *sine qua non* of their development. Only such industries are dealt with here. They are those involving electrochemical and electrothermal processes. These two processes, separately or integrated with other operations, play a large part in the manufacture of products finding common usage in the daily life of almost everyone. Some of these products can be obtained by no practical means other than by the use of electrical power; others are perfected, improved or given special characteristics by electric processing.

Some people seem to think that cheap power is not an absolute necessity for the development of industries. Their main argument seems to be that the power costs do not generally exceed 5% of manufacture costs of most goods. This might be true for some of the consumption goods manufactured in India at present, but it is not so for practically all the basic or key products which are absolute necessities for the well being of the nation, and which India imports in toto at present.

The following table taken from the Transaction of the first World Power Conference gives an idea of power costs for some of the basic goods.

N. B. Table not given in the Text ; but only *reference to Tables I, II & III facing p. 610, Vol. IV First World Power Conference —Editor*

The following table is of a similar interest. It shows the relation of the cost of electric energy to the prices prevailing in the U. S. A. in the beginning of 1938 for some of these products at assumed energy rates, ranging from 1 mile to 1percent per hour. Where available, actual average energy rates

known to have been paid by representative producers in the U. S. A. are shown in the last column.

N. B. Table not given in the text; but. reference to Table 3, p. 468 Chemical and Metallurgical Engineering Vol. 45 1938 Editor.

These figures make it absolutely clear that the development of these industries which produce the above mentioned goods cannot be carried out in India unless and until cheap electric power is available. These industries further offer a possibility of utilising large quantities of low-cost seasonal or secondary power. The development of these industries in India will be advantageous from the point of view of absorbing surplus power which will appear almost as a bye-product from the various schemes to be introduced in India for the prevention of floods, improvement of navigation, control of soil erosion, etc.

6. Need of enunciating a National Power Development Policy.

As we have shown elsewhere, the total production of electric energy and its consumption in India are very small, as compared with other countries of the world, and the price too large. Thus many industries, e.g. chemical, metallurgical, forest products and manufacturing industries, could not be started here. We may ask why is it so. The reason may be: (i) that India has no adequate power resources, (ii) that the resources exist but for some reasons have not been developed, (iii) that the existing laws regarding the generation and consumption of electrical energy are such as to retard growth of the industry, (iv) that the development has been made in such a manner and through such agencies as to give rise to vested interests, which, from selfish motives, try to retard further growth by propaganda and backdoor intrigues, and (v) absence of a state policy.

The first point can be at once ruled out, as, according to competent authorities, there is plenty of power resources in India. Sir. M. Visveswaraya pointed out long ago that not more than 2% water power resources have been harnessed. Confining only to electric power we see that it is produced in this country from coal, liquid fuel, or water power. India's poverty

in coal and liquid fuel resources has been dealt with in part B of the report. The existing data on water power resources are given in an appendix. The data presented therein relate to sites within the geographical boundariesof British India. Indian States, particularly those in the Himalayan region, contain a wealth of such resources; but they have not been surveyed. Data about such resources do not, therefore, appear in the appendix. These regions (Nepal, Bhutan, Kashmir etc.) form, however, an organic whole with India. No future scheme of development can afford to leave them out of account. The data, referred to above, have been mainly collected by the short-lived Hydro-Electric Survey of India. As we have already pointed out in section 4 by taking the case of Russia, these figures may be, for all we know, a gross under estimate.

Britains' Policy in India

We see that the resources for power are abundant in this country; but for some reasons they have not been developed. These reasons are manifold as hinted even in the beginning of this section. The first and foremost to blame, however, is the policy. Right from the beginning of British rule in India, there was an absolute absence of a sound policy of economic development according to modern scientific methods for the amelioration of the conditions of Indians. British interests demanded such an attitude. The last world war, however, gave a rude shock to all countries; and it was realised that the *laissez faire* policy in industry would not work. As a first step towards industrialisation every country had to aim at maximum production and wide utilisation of its power resources at the cheapest rates. A national policy for power was formulated in every country. Even in India the British Government was alive to it.

"The outbreak of the great war in 1914 drew forcible attention to the extent of India's dependence upon countries outside the British Empire for the supply of many of the necessities of life for her people. The government of India felt the necessity for a change in its industrial policy. In 1915, under the stress of war, the Government of India addressed the Secretary of State as follows:

'After the war, India will consider herself entitled to demand the utmost help which her government can afford to enable her to take her place, so far as circumstances permit, as a manufacturing country."

This policy was nominally accepted by the Secretary of State for India, and some governmental activity was exercised here. The Indian Industrial Commission was set up, and it made some really sound recommendations, one of them being about the fullest possible development of the power resources of India. The Commission felt that the first step towards industrialisation should be the maximum possible development of power resources, and this could not be done unless a proper survey of resources was carried out. A Hydro-electric survey was set up. It did some preliminary work, but, as has been indicated above, it was closed down soon after. From 1921, due to some mysterious reasons the Government of India appeared to have dropped all ideas of doveloping the national resources of India to make her industrially self-sufficient, and began to lay too much emphasis on agriculture and agricultural industries. Some power resources were actually developed by the U. P. and the Punjab; but, as we shall see later on, they are more monuments of mismanagement than of success. In fact, as Mr. J. W. Mears has admitted, the result of all this activity was to attract foreign machinery and plants*.

The policy of the Government, if it had the interests of India at heart, would have been much more progressive. It ought to have developed not only the power resources of the country, but also those industries where the power so developed would have been utilised. Its execution ought to have been such as to allow no inefficiency to creep in it. The existing power supply concerns which are mostly foreign ought to have been controlled in the interests of the nation, as every public utility concern ought to

*The first direct result was seen during the cold weather of 1920-21, when technical representatives of a number of large firms interested in plants for hydro-electric developments visited India to see for themselves what the prospects are, and what are the the special conditions to be met with on projects which have been already investigated. *"Introduction to Vol. III of Triennial Report of H.E. Survey of India.*

be rigidly done. The policy of inactivity adopted by the Indian Government was meant only to serve British interests for whom India was but an obliging market.

We shall now review some of the power development schemes sponsored, executed and run by the various governmental agencies, and shall see whether their execution and running has anything in common with the general policy of the Government. Such schemes are the following:—

1. Mysore H. E. Scheme
2. Madras H. E. Scheme (Mettur & Pykara.)
3. Uhl river (Mandi) Scheme in the Punjab.
4. Upper Ganges (U. P. Scheme)
5. Malakand Scheme in the N. W. F. P.

MYSORE

Though thought of about 1897, the Cauvery power scheme of Mysore State did not fructify till 1902, when the first installation was taken in hand at Sivasamudram not far from the waterfalls. This plant was soon after able to produce 4500 K. W. and electrical energy was transmitted 92 miles to the Kolar Gold fields at a pressure of 35 K. volts current in 3 phase 25 cycles A. C. At present the total capacity is 42,000 K. W. As the demand for the H. E. power has been found to increase rapidly, two new schemes have been sanctioned; one is Shimsa and the other is Jog Falls. The Shimsa scheme is more than half completed, and the Jog Falls scheme has not yet been started pending the completion of some investigation still under progress. The former is estimated to cost Rs. 57,00,000 and the latter nearly Rs.1.5 crores. "The expenditure on generation at Shiva-Samudram has been about Rs. 2 and half crores, giving an overall rate of Rs 750/- per K. W. as against Rs. 400/- to Rs. 450/- as per present market conditions. Of course this high rate is partly due to replacements, and partly due to the fact that many of these installations were carried out long ago in piecemeal; naturally costing more. The great advantage of this partial development lies in the fact that the project was not encumbered with heavy interest

charges as the works were expanded as the demand increased. The Shimsa Scheme will eventually replace the whole of the Shiva-Samudram power, as more value could be obtained at Shimsa scheme from the same quantity of water (because of higher head). If the Shimsa scheme had been thought of seriously before, probably this would not have occurred. The cost of energy to the Government, including all expenses, is a little over one pie (one twelfth of an anna) per unit, of which 20% is for administration, 25% for generation, 10% for transmission, and 45% for distribution. Mysore owes a great deal of its Industrial development to this H. E. Scheme. The power has been extended to all the neighbouring small towns and villages*."

MADRAS

Prior to 1924, the Madras Government had no definite policy in regard to electrical development, either from water power sources or from thermal electric stations. A few small company and municipal licenses existed within limited areas; and the government had also granted concessions to certain private interests to develop electric power from water sources. In 1924, the government appointed Mr. Forbes to investigate and report on the hydro-electric sources in the presidency. Subsequently the government decided that they should themselves be in charge of Hydro-electric surveys and projects as far as possible. In pursuance of this policy government bought back the Pykara concession and completed this scheme in 1933. The Mettur Hydro-electric Scheme was also taken up side by side and was completed three years later.

The river Pykara from the top of the plateau plunges down to the plains in two drops and a series of cataracts and falls about 4000 feet within a few miles. It is proposed to utilise first a drop of 3000 feet, which, when fully doveloped, will give 90,000 H.P. Later from the tail-race of this power house a channel will be taken, and the balance of 1000 feet will be utilised for the generation of another 30,000 H.P. Power is transmitted

* Inspection notes of Nawab Ahsan Yar Jung Bahadur of Hyderabad; p.4. "Sivasamudram and Shimsa Schemes."

over a trunk line and over branch lines emerging therefrom. The total length of trunk and branch lines is about 300 miles. the trunk line is 66/110 K. V. double circuit, and the branch lines 22/66 K. V.

Within five years of the date of operation of this scheme, the load developed so quickly that arrangement had to be made for additional power and the Mukurti Dam was constructed. The results of Pykara have been so encouraging that the Government of Madras have adopted a very extensive programme of rural electrification. They have installed 64,000 H. P. at Mettur on Cauvery and construction has been started on the Papuasam scheme. A net-work of transmission lines is being laid to complete the grid system.

The cost of the Pykara Scheme (1936-37) is given as Rs. 210,80,789 and the installed capacity is 24,400 K.W. which, it is expected, would ultimately develop into 67,165 K. W. The cost of installed power at Pykara is Rs. 864/- per K. W. The cost of Mettur Scheme (1936-37) is Rs. 97,49,098 and the installed capacity is 47,760 K. W. The cost of installed power at Mettur is Rs. 205/- per K. W. This does not include the cost of head work at Mettur which was mainly built for irrigation in Cauvery Delta. During the irrigation closure period the continuous power would be limited to 5750 K. W. But a great deal of this secondary and tertiary power is to be converted into primary by working it in conjunction with the Pykara Hydro-electric System. About 800 miles of trunk and branch transmission lines will be built when the total cost will go up to Rs.2/- crores; and the cost of installed power (most of the power will then be primary with the help of the Pykara scheme) will then be Rs. 400 and odd. This availability of cheap power is expected to bring about a rapid industrial development of the locality. Already some industries have developed, one of them being an electro-chemical industry which will get power at the rate of Rs. 60/- per K. W. i. e. 0.11 anna per unit.

Electrification in Mysore and Madras demonstrates what an enlightened State policy can do. The rapid development of these Provinces has been due to the policy of the Government

and to the dynamic influence of the Electric Department. As a contrast we have instances of Governmental Electrical undertakings which have been as retrograde in their working as the above mentioned undertakings have been progressive. They are theUHL River (Mandi)Scheme of the Government of the Punjab and the Ganges Canal H.E. Scheme in the U. P.

The Uhl River(Mandi)Scheme:—The UHL River in Mandi state in the Punjab is snow-fed from the Dhauladar range, which rises to 18,000 feet. The H. E. Scheme uses a gross head of 1800 feet, with the possibility hereafter of employing in series a further fall of 1200 feet below the present tail race. The initially installed plant is 48,000 K. W., though most of it would be secondary power as the discharge from the river is considerably reduced during the winter. The minimum discharge recorded in January 1923 was 98½ cusecs (which by the way was not the severest winter recorded); and for the design of the scheme it was taken to be 112½ cusecs. This would give a power output of 13,500K.W. There has been a good deal written about the cost of the Scheme. The accounts maintained have been such as to shelve part of the financial burden on to different heads. The latest official figures available with regard to finance etc. are for 1937-38, where the capital outlay on the main undertaking, and also on the local distribution, plus interest during construction amounted to approximately 7. 34 crores of rupees. The cost per unit sold in 1937–38 was 14.491, and the cost of installing primary power (13,500 K. W.) would work out to Rs. 5437/ -per K. W., whereas the cost of total power installed (both primary and secondary) would come to Rs. 1530/ per K. W. These figures show that the scheme holds the world record for dearness and mismanagement. This has been due mostly to inadequacy of data, without which a H.E. Scheme cannot be worked out, and partly to inefficiency obtaining in Government Departments. Want of any definite policy on the part of the Punjab Government, and a total absence of control and supervision by competent people on the working of the H.E. Officers of the Government, also contributed towards making the Scheme what it is. As an illustration we may refer to the varying estimates about the Uhl river scheme at different times from the initial stages of

the working of the project. i. e. 1922 to 1933. These figures appear in the following table.*

This particular Scheme has aroused considerable criticism both on the floor of the Punjab Legislature and elsewhere. We shall not enter into any such controversial matter, but quote what a competent Englishman with a fair amount of partiality towards British undertakings (and this Scheme is nothing else but a British scheme) says about it. He is no other than Mr. J. W. Mears, formerly Electrical Adviser to the Government of India and Chief Engineer, H. E. Survey of India. His opinion appears in the Appendix.†

United Provinces

The Ganges Canal H. E. Scheme of the U. P. Government was first considered by the Government in 1926. Its installed capacity in 1939-40 was estimated to be 27,900 K. W., and the total cost has come to Rs. 33·271 lakhs. The Ganges Canal passes over a series of 13 falls, varying in height from 7 to 16 feet. Of these 7 were considered suitable for electrification. The power so generated is utilised in small allotments over 13000 square miles, and is carried over 4200 miles of transmission lines. The line and transformer losses amount to 25%. The cost per K.W. installed comes to Rs.1197. The cost of generation of electricity is stated to have been 9. 2 pies per unit. Here again we see that the cost of installation has been high, as has been the cost of production. The reason for this high cost has been the decision of U. P. Government to use low falls, for electricity generation plants are relatively costly as compared with the equipment used with high fall schemes. No other alternative scheme (possibly in the Himalayas) was investigated or thought of. Each one of the generating stations has been small, and has been necessarily stationed along the alignment of the canal, which may not always be the best position from a load expansion point of view. In fact, it has resulted in excessive length of transmission lines with its inflated cost and loss in energy. The peak load of the whole system is 21,600 K.W.

* Table not given in the text of the Report—*Editor.*

† Appendix not given in the Text of the Report—*Editor.*

(1937-38); and as the limit of the H. E. Scheme is almost reached, all further power must be supplied by steam generating stations. In fact, the establishment of some steam generating stations is actually under consideration. Most of the existing load is agricultural and lasts for a comparatively short time. Since from the very beginning the cry had been raised of helping the agriculturists, such an unremunerative agricultural load has to be given preference, and no industrial load is sought for. Thus the main advantage of the H. E. Systems of supplying large blocks of electrical power at a very cheap rate for running industries has been nullified in the case of both the Uhl River and the Ganges Canal Schemes.

From the above review of the working of state-owned electrical undertakings in India, we see that many of them have been run inefficiently. Thus we see that the above inefficiencies and consequently considerable financial losses have been brought about, as no proper survey exists of the power resources and the various data necessary for the proper estimate of their development are non-existent. This has led to the development of a site which ought to have been developed when all other better sites have fully been worked out. Resulting high cost of installation and consequent high rates discouraged the use of electrical energy, and almost ruled out the use of electricity in those regions for industrial purposes for several years to come. It has resulted in locking up huge sums of money in schemes which are remunerative, neither to those to whom the money originally belonged, nor to the country at large. In most of the government enterprises there has been no check or control on the expenditure, or on those technical experts who recommended the expenditure. The choice of experts has been defective. Such defective experts, for want of proper training and experience, prepare defective schemes; and contribute towards the high costs of such schemes. As an illustration we take up the H. E. Scheme last reviewed i. e. the Ganges Canal H. E. Project. In that case the chief expert (Sir william Stamps Kt., C. I, E., I. S. E) was an irrigation engineer. That was the reason why he could think out only of utilising the falls on Ganges Canal, and it never struck him

that possibly a better source of power might and ought to be found out. Similarly all the superior officers in such Government undertakings are mostly anything but H. E. or electrical engineers. As an illustration we can take the case of the Uhl River Scheme; we give in an Appendix a question by Dr. Gokul Chand Narang on the floor of the Punjab Assembly on 18th August 1929, and the reply thereto by Hon' ble Sardar Sir Jogendra Singh (Q. 1241 of 18th August 1929)*

The only way to get out of such a scandalous position and to ensure that no such thing is repeated, it is necessary that the Indian Government should adopt a definite National Power Policy aiming at the development of all possible resources and their proper and efficient utilisation. The *laissez faire* policy adopted by the India Government has given rise to all the defects and inefficiencies to which it has been our painful duty to refer almost all over this Report.

7. Need for amending the Indian Electricity Act.

The first Electricity Act was enacted in India in 1887. This was modelled on the British Electric Lighting Act,1882, **but most of the terms imposing stringent Government control on a public utility of this type present in the British Act had been omitted.** Under this Act the term of licence was fixed at twenty one years, after which it was terminable, but renewable with the consent of the local authority, and upon such terms and conditions as the Government might determine. This limited period of twenty-one years was not liked by the financiers which were then all British. The Government met their wishes by bringing into existence the Indian Electricity Act of 1903, the original draft of which was prepared by a British firm interested in Electrical Industry in India†. For example it was found that an electrical undertaking could not, under the Act of 1903, supply electrical energy in bulk to authorised distributors. There was further dual control on electrical undertakings by the Local Governments as well as by the Governor-General in

*The question and answer not given in the Text of the Report—*Editor*

†J. W. Mears' *Laws Relating to the Subply of Electrical Energy in India & Burma, Page 5, Para 13.*

Council with all the delays and difficulties inseparable therefrom. There were other minor defects. All these difficulties were sought to be removed in the Indian Electricity Act of 1910.

The Indian Electricity Act, 1910, has since been amended as regards a clerical error in the schedule, by the Repealing and Amending Act of 1914; as regards matters dealt by the Montague Chelmsford Reforms by the Devolution Act, 1920; and generally by the Indian Electricity Act, 1922. The Indian Electricity (Amendment) Act, 1923, merely added a new section about the aerial lines maintained by railways. The Repealing and Amending Act 1925 altered a little in the Act a section dealing with the formalities to be gone through by a party applying for electrical license. The Indian Electricity Act, 1937 has substituted the " Central Electricity Board "—not to be confused with the similar British Board—in the matter of rule making for the Central Government (hitherto the Governor-General-in-Council).

Static Condition of Indian Electricity Act.

The study of these Acts shows that the only amendment of any magnitude to Indian Electricity Act, 1910, was that of 1922. It has aimed to remedy some defects in details detected in the working of the 1910 Act. These defects were mostly pointed out by the Electric Supply and Traction Federation of India (long defunct), a body formed to promote the interests of licensees and by the British Indian Electric Committee, having its headquarters in London, and looking after the interests of companies with headquarters there. Thus we see that the main provisions of the Indian Electricity Act of 1903 still hold good in this country, subject to only minor changes in subsequent amendments.

Present Position of Electricity in a Country's life.

From the above survey it will be clear that the law relating to electrical energy in India has remained stationary for almost the last forty years, in spite of the fact that social ideas regarding generation and supply of electricity have undergone a complete revolution in all countries of the world. From a luxury article which it was in 1903, it has become a domestic

and industrial necessity comparble with water supply, and is an essential element of modern life and civilisation. Electrical energy is something more than a commodity; it is the very life blood of the industrial nation which must flow abundantly and without interruption if the nation's strength and well-being are to be preserved.

Influence of the Indian Government.

The Indian Government, however, remained indifferent to all these changes going on around them in the world, and what ever little change has been brought about in its laws relating to electricity has been either to eliminate some legal flaws, or to meet the wishes of the financiers supplying electricity, as is proved by the fact that the drafting of the Indian Act was done actually by a British Company doing electrical business here.

Some features of the Indian Electricity Act.

The principal Act consists of four parts aggregating 62 sections together with a schedule of eighteen clauses. They deal with the following:—

Part I deals with the title, extent and commencement of the Act, and the definitions.

Part II expounds the law as regards undertakings working under license. It deals with licenses, works and supply.

Part III prohibits non-licensees from undertaking the business of supplying energy without sanction. It enacts that all persons transmitting or using energy in streets or in public places, factories or mines shall give notice of their intention and shall be subject to the rules and to Part IV of the Act.

Part IV contains provisions applicable alike to licensees and their consumers, non-licensees and other persons generating, transmitting or using energy in the specified places and the public generally; together with a number of general provisions to facilitate the smooth working of the Act.

The schedule consists of—Provisions deemed to be incorporated with, and to form part of every license granted under Part II, so far not added to, varied or excepted by the license. It deals with :—

Security and accounts.
Compulsory works and supply
Supply by bulk licensees
Charges
Testing & inspection
Plans
Additional notices of certain works

Theoretically the Act makes clear that a license is not to have the effect of a monopoly, but there has not been a single case of competition being ever considered in order to get better terms and services from the licensees.

A licence can also be revoked if the terms of the licence are not adhered to, or the provisions of the Act are disregarded. The undertaking can, on revocation, be purchased by the local authority with the consent of the Government, and upon certain terms, or it can be sold to other parties .The value to be paid would be the fair market value at the time of purchase without any addition in respect of compulsory purchase or of good will or of any profits which may be or might have been made from the undertaking.

A license is also subject to compulsory purchase. The option of purchase, where it is a condition of the license, first arises after a period (to be stated in the license) not exceeding 50 years, and subsequently recurs at intervals not exceeding 20 years. If no purchase takes place, the licence continues in full force until the next option arises. Two years' notice must be given to the licensee of election to purchase in any case; but instead of purchasing, the local authority may, with the consent of the Government, strike a bargain with the licensee as to working on terms to be agreed upon. In the Act of 1903, the terms of compulsory purchase were the same after 42 years as in the case of revocation (i. e. the terms then in force in Great Britain) given above. Subsequent amendments to that Act, however, yielded to the representations of the companies carrying on business in electrical energy, and allowed for an addition up to 20% to be given, over and above the market value as a solatium for compulsory purchase. The fair market

value is to be determined by arbitration, just as though no addition were to be given and the percentage is then to be added in order to determine the actual price to be paid. Apparently, it would be possible for the licensee to spend a large sum on extensions at the last moment in order to obtain an immediate return in the form of the bonus. There is further a provision in the Act which permits the Provincial Government to so frame the terms of the licenses as to make inoperative the provisions of the sections dealing with compulsory purchase. In such a case there cannot be any compulsory purchase.

The Act entitles every applicant for electrical energy to a supply on the same terms as any other person who in similar circumstances has a corresponding supply. So long as the licensee does not show undue preference, the charges may be such as are agreed upon upto the maximum allowable by the license. No person, however, having private generating plant is entitled to demand a supply on the usual terms.

The Act entitles every licensee to charge for electrical energy at a rate which does not exceed the maximum rate set forth in the license. The Provincial Government can at any time after the expiration of seven years from the commencement of the license, have the maximum rate altered. They must, however refer the matter to an Advisory Board and the alteration can be made only after its recommendation. The Act further entitles the licensee to make a minimum charge even if no energy had been consumed. It is argued that this minimum charge provides a reasonable return on the capital expenditure incurred on the consumer's installation. But the rates are equally high even when the consumption is greater than that covered by the minimum. Such a system does not obtain at any place where the system of minimum demand is operative. The Act further lays down that the charges for energy may be based upon and vary in accordance with any one or more of the following considerations, namely:—

(a) the consumer's load factor, or
(b) the power factor of his load, or
(c) his total consumption of energy
(d) the house at which the supply of energy is required.

These variations would, however, under the present conditions, be made to suit the licensees rather than be guided by social or national considerations.

The Act is not very explicit about the monetary matters arising out of the affairs of the electricity undertakings. "The license is frequently granted in the first place to some individual or firm, with a view to subsequent transfer to a company with limited liability, Such transfer may only be effected with the sanction of the Government, (S. 9) though it is well understood that this will generally be applied for; and there is no reason why it should not be granted as a general rule". Thus writes Mr. Mears, formerly Electrical Adviser to the Government of India on p. 114 in the 5th edition of his Book dealing with Indian Electricity Act. He further adds that the capital upto the present time has largely been subscribed in London. This practice had led to over capitalisation and other financial defects, very much found in Indian electrical undertakings and about which we shall deal later on. It gives rise to purely speculative applications, where the intention is merely to keep out other probable licensees until the holder is bought out at his own price. The Act, as it is at present constituted and run, cannot check these defects.

The Act does not specify anything about the rates of depreciation, reserve and such other funds as are to be maintained in an electrical undertaking. In other countries, they are legally fixed. In the absence of such a provision financiers are free to do what they like with respect to these funds, giving rise to, ultimately high rates of charges for electricity.

The schedule of the Act provides that a licensee shall, unless otherwise directed, "at all times keep the accounts of the capital employed for the purposes of the undertaking distinct from the accounts kept by him of any other under taking or business." In point of fact, it is not done (Mears, loc. cit. p. 116). Sec. II of the Act lays down that annual accounts of all undertakings not specially exempted are to be rendered to the Government made up to such date, in such form and containing such particulars as may be prescribed

by the rules. The value of such accounts cannot be overestimated. These accounts must be audited in such a manner and by such persons as Government may appoint and the licensee must afford to the auditor access to all books, documents, vouchers and information and must afford all facilities for the audit. Actually, the audit of a chartered accountant appointed by the company is often accepted. Thus although the Act lays down the auditing to be done by auditors appointed by Government, in actual fact, the statement furnished by company auditors is accepted. This practice has not been conducive to the very best interest of the country.

The duty of securing that licensees, non-licensese, consumers, owners and other persons comply with the conditions imposed on them by or under the Act and the rules, falls on the various Inspectors appointed under the Act; they are therefore actually responsible for the impartial administration of the law, as the specialist advisers of the Government which appoint them and the expert witnesses for the Crown in any case which come before the Law Courts whether instituted by them (S. 50) or not. They are not concerned with the final interpretation of phrases which is a matter for the Courts ; but as practical experts (rule 4) acquainted with the common sense meaning of words with the limits of what is technically and commercially practicable to bear on any case with which they are concerned. Rule 4 of the Indian Electricity Rules 1937 prescribes the qualifications of an inspector. The provision in the rule is defective in so far as it allows Government great latitude in applying it in as much as it permits persons to be so appointed who are not competent.

The Central Government and the Provincial Government may constitute Advisory Boards. Though this provision was in the Act of 1903, no Advisory Board was ever formally constituted under the Act.

Similarly, no Board was ever constituted under the present Act between the time of its enactment and 1916. In that year a Committee of which the Author was a member was appointed by the Bengal Government to enquire into the rates charged by the Calcutta Electric Supply Corporation to consumers; the Committee was "appointed in pursuance of Cl. XI of the

Schedule to the Act" which makes it incumbent on Government to refer such matters to an Advisory Board. A similar enquiry was made regarding Patna rates in 1932.

Under S.36 (3) an appeal from the decision of an Inspector may, if Government (or the Governor of Burma) by general or special order so directs, be referred to an Advisory Board. Unless this is done the Inspector as Technical Adviser to the Provincial Government in many Provinces virtually decides appeals from his own decisions in another capacity.

Under Cl. XI of the Schedule, as amended in 1922, if Government contemplates making an order altering the maximum rates in any license it shall (i. e. must) refer the matter to an Advisory Board; and if the Board recommends any alteration the Government may make an order accordingly.

These are the only matters which the Act definitely refers to the deliberations of an Advisory Board.

Under the former constitution, upto 1937 the Governor General-in-Council was the sole rule-making power under this Act. The 1937 amendment enacts that a Board to be called the "Central Electricity Board" shall be constituted to exercise the powers hitherto exercised by the Governor-General in-Council.

(1) The Central Electricity Board shall consist of fifteen members, namely:—

(*a*) a chairman to be nominated by the Central Government.

(*b*) one member to be nominated by each of the Provincial Governments of Madras, Bombay, Bengal, the United Provinces, the Punjab, Bihar, the Central Provinces, Assam, the North-West Fronter Province, Sind and Orissa.

(*c*) one member holding office for a period of three years to be nominated alternately by a provincial Government of Delhi and the provincial Government of Ajmer-Merwara.

(*d*) one member to be nominated by the Chief Commissioner of Railways; and,

(*e*) one member to be nominated by the Chief Inspector of Mines.

The Central Electricity Board may make Rules for the whole or any part of British India, to regulate the generation, transmission, supply and use of energy, and generally to carry out the purposes and objects of this Act.

(2) In particular and without prejudice to the generality of the foregoing power such rules may—

(*a*) prescribe the form of application for licenses and the payments to be made in respect thereof.

(*b*) regulate the publication of notices.

(*c*) prescribe the manner in which objections with reference to any application under Part II are to be made.

(d) provide for the securing of a regular, constant and sufficient supply of energy by licensees to consumers, and for the testing at various parts of the system of the regularity aud sufficiency of such supply, and for the examination of the records of such tests by consumers ;

(*e*) provide for the preparation and submission of accounts by licensees in a specified form:

(*f*) provide for the protection of persons and property from injury by reason of contact with or the proximity of, or by reason of the defective or dangerous condition of any appliance or apparatus used in the generation, transmission, supply or use of energy ;

(*g*) for the purpose of electric traction regulate the employment of insulated returns or of uninsulated metallic returns of low resistence in order to prevent fusion or injurious electrolytic action or on metallic pipes, structures or substances and to minimise as far as is reasonably practicable, injurious interference with the electric wires, supply-lines and apparatus of parties other than the owners of the electric traction system, or with the currents therein, whether the earth is used as a return or not;

(*h*) provide for preventing telegraph lines and magnetic observatories or laboratories from being injuriously affected by the generation, transmission, supply or use of energy.

(*i*) prescribe the qualifications to be required of Electric Inspectors;

(*j*) authorise any Electric Inspector or other officer of a specified rank and class to enter, inspect and examine any place, carriage or vessel in which he has reason to believe any appliance or apparatus used in the generation, transmission, supply or use of energy to be, and to carry out tests therein and to prescribe the facilities to be given to such Inspectors or officers for the purposes of such examinations and tests;

(*k*) authorise and regulate the levy of fees for any such testing or inspection, and generally for the services of Electric Inspectors under this Act; and

(*l*) provide for any matter which is to be or may be prescribed.

The above analysis of the Indian Electricity Act shows that, although it is very much defective, in as much as it neglects the social and national responsibility of electrical undertakings in giving better, wider and cheaper services, it does contain some provisions enabling the Provincial Governments to exercise certain amount of control on their activities. The various instruments of control on the part of Provincial Governments have been: the Electrical Inspector and the Electrical Adviser (usually one man carrying on both the offices), the Advisory Board (never seriously constituted), and the Central Electricity Board (a theoretical and very defective organisation still on paper). That these instruments have been working inefficiently can be seen from an analysis of some electrical undertakings in this country as given in the following section. There have been very few investigations in the complete working of Indian Electrical Undertakings taken as a whole and covering their financial, technical and administrative aspects, as well as the services they render to the country. Some isolated cases of popular criticisms forced the workings of some of the electrical

undertakings to be examined. In each and every case it was found that the working was defective and the rates charged were too high.

One does not know whether the electrical inspectors and the electrical advisors to the various Provincial Governments were not vigilant, and did not suggest proper steps to be taken by the various Governments to rectify the defects, or the Governments themselves, although they got the right advice, did not act up to it. One thing can, however, be said, without much of uncertainty, that amongst themselves, the Provincial Government and the Electrical Inspectors and the Electricat Advisers to those Governments have been guilty of a gross neglect of the interests of the country and the consuming public, and have been shirking the duties and responsibilities imposed on them by the Indian Electricity Act. As an illustration we may point out that the Committee inquiring into the working of the Electrial Supply Undertakings at Calcutta in 1935, recommended certain immediate reduction in rates and visualised a further reduction in the very near future. Although the recommendation for immediate reduction was accepted by the Government, no subsequent reduction was effected.

The Government of Bengal had a chance of revising the licence of the Calcutta Electric Supply Corporation in 1938 when its term had expired. But in spite of a strong public agitation for stricter governmental control, Indianisation of services and assumption of entire service by the Government (which would have brought an additional income of Rs.2/- crores to the public exchequer) nothing was done by the Fazlul Huq Ministry. The U.P Government likewise appointed a Committee for inquiry into the working of electric supply undertakings in that Province. The committee is reported to have laboured for two years without producing any result.

8. The Present High Rates for Energy; their causes and proposed Remedies.

The rates for electricity charged from consumers all over India are unnaturally high and bear no relation to the actual cost of production under all headings. They are sometimes

three to four times higher than in the cities of other countries placed in similar circumstances.

In order to get a comparative idea of the working of some electricity undertakings the following figures are quoted from "Electrical Times", 1st June 1939. Only two Indian stations have been taken and compared with several similar British stations. The Indian stations are representative. Calcutta is a big city with cheap coal and concentrated load. It can be compared to London, Sheffield etc. Hyderabad (Sind) is, on the contrary, a medium station with costly fuel.

PRESS NOTE

"With a view to protecting the interests of the consumers of electrical energy, the Government of Bombay had announced in a Press Note, dated the 25th Feb. 1938, certain additional conditions subject to which every electric license would be granted. After considering the objective and suggestions received, Government are now pleased to direct that every electric license to be granted hereafter shall be subject to the following additional conditions in supersession of those announced in the Press Note, dated the 25th February 1938 :—

(1) That from the net profits the allotment to the licensee (or the shareholders) shall in the first instance be limited to 6% which rate shall not be cumulative, any surplus over this being distributed equally between :

(a) the licensee (or the shareholders)

(b) the consumers

The limitation shall not, however, come into operation until 3 years after the date of the commencement of supply.

(2) That government will have the right to nominate a Director on the Board of a supply company.

(3) That government will appoint or approve the appointment of, an auditor to examine the annual statement of accounts of the undertaking under Clause II of the schedule to the Indian Electricity Act, 1910.

(4) That no license shall be transferable except to a Company which may be floated for the purpose, and then only on the basis of actual expenditure incurred by the licensee in securing the license and of any other capital expenditure incurred.

(5) That no license will be granted until the licensee has deposited with Government 20% of the total estimated cost of the works, this amount being refunded to him in instalments from time to time according to the value of the purchase and work done.

(6) That special maxima rates for power to be supplied to the agriculture and small industries shall be laid down in every license; these rates being based on the cost of generation and delivery of such power.

(7) That the option of purchase given by section 7 (1) of the Indian Electricity Act shall be exercisable, first, on the expiration of 30 years from the commencement of the license; and thereafter on the expiration of every subsequent period of 19 years therefrom.

(8) That before granting a license to a company, government shall have the right to examine any agreement between the company and their Managing Agents, if any, and to require suitable modification therein as a condition precedent to the grant of the licence. A provision shall also be incorporated in a license granted to a company that any agreement between the licensee and the Managing Agents shall be subject to the approval of the government. If the license is granted to an individual, and it is afterwards sought to be assigned to a company, Government will also then exercise control in a similar manner while granting the necessary consent under section (2) of the Act.

(9) That should a continuous supply of energy of a nature and an amount and at a point suitable to the purpose of the license be offered by any person or government willing to enter into an agreement with the licensee to supply energy to him

for a period of not less than 7 years at such a charge that any of the limits of prices to be charged by the licensee could, in the opinion of Government, be reduced below the limits fixed by the license, as it stands or as it may be subsequently amended, the licensee shall, from such date as government may fix, enter into such agreement with such person or government. The decision of the government on the operation of this condition shall be final.

(10) That Clause XI of the schedule to the Act shall for the purpose of incorporation in the license be added to as follows:—

"Provided further that where an order in pursuance of condition (9) above has been made, the maximum charges fixed by the licensee or as it may be subsequently amended shall be reduced by amendment of the license to such extent as government may fix."

(11) That the licensee shall, whenever so required by government, employ as unpaid apprentices passed candidates from the Mechanical and Electrical Engineering Institutes in the Province of Bombay for a period of one year's training in connection with the power station and distribution system.

Provided that the number of such candidates to be employed at one time shall be limited to two."

The above Press note was issued only when the Bombay Government had received the findings of the Committee appointed to examine the rates and charges at present levied by the Electrical undertakings in Bombay Presidency and had considered them. From a close study of it the following findings of the committee can be inferred.

(*a*) **Genesis of creation.**

It has been the practice for an individual or a Syndicate to obtain the requisite license from Government in the first instance, and then to form a limited liability company to take over the license from the Syndicate. The consideration for the transfer of the licence usually consists in the payment of a certain amount in cash and the allotment of a certain number

of shares *depending on the authorised capital of the newly* formed company. Simultaneously a contract is entered into, *binding the Company to appoint one or more of the members of* the Syndicate as Managing Agents for such *period as the agents* themselves choose to remain in office, with a stipulation for the payment of an office allowance and a commission ranging from 5 to 15 per cent of the net profits of the Company. The net profits according to the contract agreement *inter alia* uniformly exclude depreciation charges as an item of working expense. The net profits for the purpose of commission are, therefore, always more than the actual profits. In some cases, again, as part consideration for the transfer of the license, the original licensees are appointed under the contract agreement as sole contractors for the supply of materials and construction of works, thereby eliminating competetive rates for materials required for the Company's works. In some companies the principle of sub-infendation is carried still further.

(*b*) **Over Capitalisation of Stock (commonly known as 'Stock-watering' or 'Inflation of Stock')**

Most of them considerably water their stock; and so in determining a fair return to the shareholders this factor should be taken into account.

In the organisation of a private concern it is permissible to issue securities against assets as well as against the good will and other earning powers of the concern. In the case of a public utility, however, the stock (the share-capital) should be represented rupee for rupee by physical assets. The extent to which the share capital is not backed by tangible assets, the stock may be said to have been watered.

(*c*) **Repairs and Maintenance.**

Expenditure on repairs, renewals and maintenance present great difficulties, as the wrong allocation of an item of expenditure either to Revenue or to Capital affects the working cost and therefore the rate. Broadly speaking, if as a result of repairs or renewals, the value of the property as an asset is increased, the charge to such extent as the value is increased should be

made against capital. Where the company is making substantial profits, the tendency has been to charge all repairs and renewals to revenue, while with the less fortunate companies the tendency has been the other way.

(*d*) **Managing Agent's Commission.**

The remuneration to the Managing Agents generally takes the form of a fixed office allowance per month, and a commission based on the net profits at rates varying from 5% to 15%. This net profit is calculated in all cases without charging the commission payable to the Agents and depreciation, and usually excluding interest on debentures, capital expenditure and appropriation to reserves.

There is usually a long term contract between the Agents and the Company providing remuneration at the varying rates stated above. These contracts, though based on economic conditions at the time of their negotiation, are under changing economic conditions transformed into heavy liabilities. While therefore, the Managing Agents are protected by legal contracts, it has to be borne in mind that the shareholders of a company cannot in equity allow to their managing agents a high rate of remuneration, and at the same time claim the full fair return on the capital invested by them. The equity in favour of those companies where the managing agents, as majority shareholders, have the right to bind the company to a contract with them, is still less. Thus in neither case can the whole of the remuneration paid to the agents enter into the "Rate Charge".

(*e*) **Reserves.**

The following reserves are generally met with:—

(1) General Reserve

(2) Dividend Equalisation Reserve

(3) Insurance Reserve

(4) Bad and Doubtful Debt Reserve

(5) Workmen's compensation Reserve.

Apart from these there is another reserve which is not generally shown on the Balance Sheet. The amount at the

credit of the Sinking Fund created for the purpose of redeeming debentures is a kind of reserve as this will acrue to the General Reserve when the debentures have been paid off. As depreciation is charged separately to revenue in respect of the assets for which the mortgage or loan was taken, it is resonable to include this sum in the Reserves of the company. Reserves for Bad and Doubtful Debts being earmarked for a specific purpose, no objection can be taken about their adequacy or otherwise. The rest of the reserves are free reserves; and there is no established practice as to the amount that need be set aside. A fair estimate is that 10% of the net block should be considered sufficient to meet all unforseen contingencies, to be accumulated by an yearly contribution from revenue of not more than one quarter of one per cent per annum of the net block.

(f) **Fair Value of Assets.**

It is contended in some quarters that a 'fair return' should be based on the amount of share capital invested by the shareholders in a company. This claim is untenable, because, on the one hand, there might have been undue 'watering' of stock; while on the other hand it would manifestly be improper to deny to the shareholders a return on the capital expenditure met out of accumulated reserves of the company. For the purpose of determining a 'rate base', therefore, the value of the properties at the service of the public is the correct basis. The process of valuing the properites is, however, beset with difficulties, as even eminent jurists do not agree to the exact meaning of the term 'Value'. When a company invests its D preciation Reserves in the business itself, it, in effect, borrows the amount so invested from the Reserves; and should, therefore, pay interest to the Reserve which it would have earned, had it been invested outside. The result of providing interest is that charge to the operating expenses on account of depreciation is diminished. Instead of reducing the provision of depreciation by the amount of interest payable, the value of the properties should be reduced on which a return has been calculated by the amount of the Depreciation reserve.

(*g*) Fair Return.

It is being frequently argued that investors in public utilities should get a fair return on their investment. It is very difficult, however, to lay down what this fair return should be. In determining a fair return, the fact that the public in the early stages, when electricity was regarded as a luxury, took a considerable amount of risk, in investing their money in these enterprises should not be lost sight of. Again like any other investment, the capital must bear a certain amount of interest which shonld not be less than the current rate of interest. Lastly, the investors must be insured against any possible loss of their capital such as by obsolescence or loss of Franchise, so that the capital will naturally be drawn into the public utility fields.

(*h*) Audit.

Government allows the electrical undertakings to drift without proper regulation for too long a period. Many devices have been adopted by the Utility financiers, some of which cannot be said to be in the best interests of the public at large. In the matter of audit, Government have been deprived of a most valuable help and guidance, which they have a strict right to, from their anditors. In accordance with the existing arrangement the companies' auditors also act as auditors on behalf of Government. Without in any way making any reflection on the present company auditors, it may be said that the company auditors acting on behalf of Government have not only to see that there is a voucher for every payment, but have also to see that the payment itself is such as an ordinary business man of prudence would incur. The financial audit in this latter sense is much more important from the Government point of view than the mere voucher audit.

Government should lay down that the Auditor shall append to the annual statement of accounts a report dealing *inter alia* with the following points:—

(a) Whether he has satisfied himself that only those items which properly belong to the capital account have been debited

thereto, and that nothing has been charged to revenue account which should properly be debited to the capital account.

(b) Whether in his opinion the rates for energy charged to the consumer are reasonable, and not capable of appreciable reduction. His reason for arriving at his conclusion should be explained with reference to the revenue, profits and appropriation made from the revenue to the various reserve funds.

(c) Any other particular point or points on which special information is at any time desired by Government.

Although the Enquiry Committtee in the Calcutta Electricity Supply Corporation went very superficially into the matter, their findings too essentially agree with those of the Bombay Committee. One can see, therefrom, that the electrical undertakings have been resorting to all sorts of means in order to inflate their profits, and of those of their managing agents without their being unduly exposed to the public gaze.

There are cases of holding companies controlling several electrical undertakings indulging in financial manipulations of a character peculiar to such bodies. The managing agencies of many of the Electric Supply Companies in this country are in the hands of financial groups who form part of a much bigger concern. Such concerns are known technically as "Holding Companies".

As an illustration, we take the case of Messrs. Martin & Co., who are managing agents of many electricity supply undertakings in Upper India. they are also the managing agents of dozens of other concerns, involving mining, iron metallurgy, cements, general engineering, imports and exports, and general contracts. All the contract work, purchase of machineries for their Electricity Supply concerns are done by themselves in uncompetitive markets; and nobody has enquire whether these transactions are carried out in the best interests of the consumer in the locality concerned. This applies to other Electricity Supply companies as well. The Tata group of companies in Bombay is just another example of such companies working in India. Calcutta Electricity Supply Corporation is an instance of an enterprise governed by a huge foreign combine.

The evils of a holding company are thus described in the P.E.P. Reports:—

"Tho objects of the holding company are to concentrate control in a few hands, and as a rule to broaden the basis of security for its investments by a variety of holdings which may be spread over areas of different character. Such holding companies may raise capital for the development of new areas, and may create a body of technical and managerial skill to further the efficient dovelopment of subsidiary businesses.

The engineering efficiency of the group in securing proper development of service, may, however, be counterbalanced by financial activities of a different character. Inflated values may be paid for individual undertakings in order to obtain control; the fees and costs of merging companies may represent a serious addition to the capitalisation. Recapitalisation may occur, and the contracts for engineering, management and supervision of development for the subsidiary operating companies may involve unreasonably high charges to the latter. Where the holding company has control or close association with a manufacturing concern, it may disseminate excessive profits in the payment of exeecssive prices for equipment.

In this way it may evade criticism of excessive profits by the government or the public, since the manufacturing concern is thus allowed to absorb some of the profits of the supply companies. The holding company may also own contracting firms engaged in carrying out the business of installations for lighting, heating and power; and transfer to them, through unnecessary high prices for these services, a proportion of the profits resulting from the supply of electricity. It may again force consumers to use the service of such firms, and make excessive profits for them on wiring and contracting at the direct expense of the consumer. It may own finance companies engaged in financing the hire-purchase of consumers' apparatus, and transfer some of its profits to them. It may derive excessive profits through its power to transfer to this type of company a large volume of trade in consumers' apparatus.

Further, the system of pyramiding control upwards which has developed in the United States enables a small investment at the apex of the holding company pyramid to control a very large range of subsidiary companies.

"As American experience has shown, the holding company system lends itself to capital inflation, over-valuation of assets, instability of administration, and high prices for service.

To sum up, the holding company, under modern conditions, is one of the most elusive, and one of the most difficult organisations to control in the interests of the consumer; and neither the Electricity Supply Act 1926, nor the Companies' Act of 1929, has provided adequate control over its operations".

We further illustrate the very shady working of such holding companies by citing the case of an English Company in appendix. Lord Meston, who is the Chairman of the Board of Directors of the Calcutta Electricity Supply Corporation, features prominently in the illustration of the English holding Company.

Such financial companies, who virtually hold the monopoly in running public utility concerns, are a menace to the society and the nation; because with the backing of huge capital of the entire combine, they are and would prove in future to be the most refractory to any change or modifications proposed to be introduced in their working for the benefit of the society and the nation.

So far most of the superior experts, particularly in foreign companies, have been foreigners. It is a general impression that such foreign experts are unwilling to give any training to Indians, or offer any scope to their Indian subordinates to gain proper knowledge and experience. The well-known arguments given by the late Mr. G.K. Gokhale with regard to the employment of foreigners in civil service, apply to this case more forcibly. The foreign expert gets his experience and practical knowledge at the expense of India; and then retires to his country at a period of life when his mature experience would have been of the greatest service to this country in further development.

All the equipment and machinery used by the electricity supply undertakings have been foreign, and continue to be foreign; because being part of a big concern, they have to buy all their stores and replacement machineries not from competitive markets, but from firms allied to them, mostly at non-competitive rates. No effort is made by these companies to foster the growth of manufacture of electrical apparatus either themselves, or by extending patronage to Indian concerns. Thus they are not only increasing their cost of production of electricity, and therefore its sale price, but are also retarding the growth of industry which would have given employment to lacs of people.

All the above factors working separately or jointly contribute towards increasing the cost of production of electricity.

There are other causes working towards making the rates high. They are the present low load densities, and low load factors resulting in an unduly small revenue in relation to the cost of works. In smaller undertakings the high rates are also due to the generation of power in small inefficient power houses for supplying small urban areas. In some cases, in spite of progressing improvment of load conditions, and in spite of the technical efficiency of the schemes, the supply companies have failed to reduce the rates correspondingly. The exact position has been kept away from the public under the cover of many financial manipulations.

To sum up, the rates for electricity charged from consumers are in this country unusually high, and according to our analysis are due to:—

(*a*) High installation costs:—The cost of installing electrical power supplying machinery in India has been, except in a few cases extremely high. This has been mainly due to:—

(i) Defective planning, as it was based on insufficient data, particularly hydro-electric, without which no work should be undertaken.

(ii) On the part of holding companies financial manipulations of a nature which may be tolerated in other industries, but are absolutely incompatible with the principles under which a Public Utilities Company like a Power Company should operate.

(iii) Due to necessity of importing all materials, apparatus and instruments needed for construction from foreign countries.

(iv) Defective technical knowledge available in this country. Practically all the electrical power supply undertakings have been designed, set up and run, at least in their early stages, by foreign engineers either on behalf of foreign companies or even of Indian ones.

(v) High cost of running the machinery :—The causes are complex and vary from one company to another. They are :—choice of improper machinery, costly technical staff imported from abroad, high price of repair and replacement of materials which have to be imported from outside, but mostly due to financial manipulation on the part of undertaking companies, against which there are inadequate safeguards for the protection of the consumers. In the case of government sponsored undertakings there has not been a proper control over the different items of expenditure.

(vi) In most cases the suppliers of machinery and equipments were entrusted with the design of power plant, and with the fixing up of specifications of equipments of the power plant The suppliers being businessmen, and having the intention to sell as much as possible, consequently, specified costlier machineries of larger output, and even unimportant equipments and thereby the cost of installation increased.

(vii) Absence of any serious effort to utilise the surplus power and increase the load factor by the government and the electrical industry.

In order to improve this state of affairs some measures are indicated in our recommendations.

It would be further necessary to make a budget for all these enterprises, not for one year as in the normal procedure, but for a fairly long period. Such long period budgets have been adopted both in England and U.S.A. The advantage in framing such budgets is that very cheap rates can be quoted from the beginning when the demand for, and, therefore, the output of power is small. These low rates help in building rapidly the demand for power and the country gets the advantage of cheap power right from the beginning. The undertakings suffer deficits in their early years which, however, go on reducing; and there is a saving only when the entire budget period is considered.

In England, for example, the Electricity Act, 1926, contains provisions designed to ensure that the greater part of the benefits of the policy of inter-connection should reach the consumers of electricity, and should not be retained by the Utilities, for the purpose of either increased remuneration of capital or alleviation of local taxation.

It was realised from the inception of the scheme that, while on the one hand it was necessary to incur the capital expenditure incidental to the construction of the grid at the outset, on the other hand the achievement of the economies in capital and operating costs must be a more gradual process, and dependent upon the growth of demand for electrical service. The act, therefore, required the Board to adopt a method of budgeting which would allow the introduction of low rates from the beginning. Not only was the Central Electricity Board empowered to capitalise interest for limited periods, and to suspend for a time the annual provision for the redemption of its loan; but it was required to fix the grid tariff at such a level that the receipts on revenue account would be sufficient to cover the revenue expenditure, not annually, but over a period of years to be approved by the Electricity Commissioners, leaving at the end only a safety margin. The period adopted was ten years and in the earlier years of trading the income has been insufficient to meet the full service of the capital; and it would be only in the later years when surplus revenues will be available sufficient to recoup the earlier deficiencies and leave the requisite margin.

9. Implications of the Industrialisation Policy adopted by the N. P. C.

According to the Red Book published by the N. P. C. (page 40,11) the industrial output of India is to be increased 2 to 3 times within the next few years, and five to six times ultimately. For the total industrial output contemplated therein, the total energy production in India from machinery has to be increased by at least, 25,000 million units within the next ten years, part of which may be forthcoming from steam engines, bnt most can come only from electrical power. According to our estimate, about 12,000 million units of energy should be electrical; and this would require installation of additional electrical plants with a total capacity of about 3 million K. W., assuming that the load factor can be improved as we have visualised above. According to our investigations, the capacity of total electrical plant at present installed is about 1.I5 million kilo watts, and the capital invested amounts to 90 crores of Rupees. The total capital required for the developmental work we have in view would be about 240 crores of Rupees.

The following table gives an idea of the present capacity of electric plants in this country. The figures have been taken from a memorandum submitted to us by one of our members, Dr. Ram Prasad.

It is estimated by some Engineers, that allowing 100 units per capita, a total of 35,200,000,000 K. W. Hours wound be required and with a utilisation factor of 4000 hours a plant capacity of 8,800000 K. W. excluding spares would be repuired.

The total water power resources capable of practical development is estimated at 5,500,000 K. W. which shows that less than 10% of the water power resources of India has been developed. The installed capacity of steam electric plants in India is estimated at about 700,000 K. W. and this may probably increase to about 800,000 K. W. during the next five years.

10. Case for State Control for Power Development and for Existing Power Companies.

The Electricity development in India has so far been confined mainly for the service of the cities and larger towns, rail-

way workshops, and a few centres of heavy industry. Both fuel and hydro-electric power stations built by State and Private agencies are in service. These developments have generally been of a character where loads are concentrated; and therefore, the promoters of the undertakings did not have to wait for long before the investments began to yield returns. Further developments of electrical power, however, would mainly have to be of a different character. New power stations and/or extensions of existing stations and new loads mostly for industrial purposes, have to be planned as one scheme. The new loads would be the power demands of the heavy chemical and manufacturing industries, and making electric power available to the smaller towns and to the countryside for small industries, lift irrigation, protected water supplies, etc. The latter demands are particularly pressing needs in the interests of the economic well-being of the bulk of the population of the country which lives away from cities and towns.

The different demands of the new power developments can be best served by the establishment of central thermal and hydroelectric power stations and networks of transmission and distribution lines. Such schemes have been planned, and are now in operation in Mysore and parts of United Provinces, Madras, the Punjab and North Western Frontier Province.

We have tried to show that most of the undertakings in India have been excessively expensive, and have analysed the causes which are technical, financial as well as administrative. The technical problems, particularly concerning H. E. developments are of such a colossal nature that it is difficult for a private body to deal with them adequately. Such a view has been held even by the Indian Industrial Commission. The capital required for all installations, especially for H. E. Power stations is so high that it taxes the capacities of most private companies. Even if such capital can be found by some financial syndicate, which in the case of this country would most probably be foreign, it is unsafe, as experience all over the world shows, to entrust any private body with the execution of large projects of power development and supply; as they in practice tend practically to become monopolistic, care only for individ-

dual gain and are not alive to social considerations. Further H. E Developments involve questions of flood control, irrigation, soil conservation and interference with the normal functions of the drainage basins. These functions cannot be handed over to any private company which works for the motive of private gain alone. In fact, no private party or individual ought to be given the rights to develop water power.

State Control—The general trend

The present trend of legislation with respect to power supply is towards nationalisation of energy resources, totalitarian control by the State, extension of facilities to all places where men live, maximum possible reduction of costs, and the greatest possible energy consumption. The State must actively plan and cannot limit itself to a passive role and abandon its duty to ensure as wide a market as possible for power at reasonable rates. As president Roosevelt remarked, "It is not that we do not have enough electric power, what prevents us from taking advantages of our own resources is that many selfish interests which control electricity are too short-sighted to understand that moderate rates would result in greater utilization of electric power. The price which is paid for a public service is a determination of its use."

We shall illustrate our point by referring to policies adopted in various countries.

ENGLAND

"Prior to 1926, the state of affairs in England, though much better than that at present existing in India, was not very satisfactory. The British public supply of electricity was carried on by supply companies and municipal; authorities and the public were at the mercy of the supply companies who, like their counterparts in India, showed extreme reluctance in reducing their rates even when it was possible for them to do so. By successive legislation since 1882, the government of the United Kingdom have now brought under control the production and distribution of electricity.

"The Great War necessitated an entire change in the general attitude to the production and distribution of electricity, and radical modifications in the existing laws were proposed.

The exigencies of the War revealed electricity as a vital agent of industrial production. They brought out sharply the defects in the legislative situation by which co-operation in production and distribution was impracticable and isolated development was fostered. The inter-connection of generating stations, desirable with a view to economy in plant, coal and other items of cost, was urged upon electricity undertakers by a Board of Trade Circular in May 1916, and a special department was formed under the Ministry of Munitions to organize the supply of Electrical Power."

A number of committees were appointed, and the report of these led to the passing of Electricity Supply Act in 1919 (amended by the Act of 1922). The Act provided for the appointment of five Electricity Commissioners whose general duties were defined as promoting, regulating and supervising supply of electricity. The appointment of these commissioners was in itself a statutory revolution. The Act inspired confidence in the future of the Industry, it broke down many prejudices, municipal, political and official. The next great change effected was in January 1925, when the government of the United Kingdom appointed a committee under the presidency of Lord Weir to consider the general question of immediate and future development of electricity in the country. Acting on the findings of the committee, the Government introduced a bill in the House of Commons in March 1926, which was passed into an Act, called the Electricity (Supply) Act of 1926. The greatest change introduced was the establishment of a Central Electricity Board, having a constitution similar to that of an industrial company outside direct parliamentary control. The Board aims at complete reorganisation and control of generation of electric energy for the whole of Great Britain. The main functions of the Board were :

(1) To construct giant power stations located in industrial areas and operated by public supply undertakings under the

directions of the Board in accordance with a technical scheme for the country.

(2) To erect a comprehensive network of main transmission lines covering the whole country, and inter-connecting all selected stations where generation would be concentrated (Popularly known as the Grid System).

(3) To standardise the frequency of the supply.

(4) To supervise the scale of electrical energy and to authorise distribution at cost price.

"This proposed not a change of ownership, but the partial subordination of vested interests to that of a new authority for the benefit of all, and this only under proper safeguards and in a manner which will preserve the value of the incentive of private enterprise."

It was estimated that by thus concentrating the production of electricity, the average working cost of energy would fall from ·94d. as recorded in 1925 to ·4d. (·37 as.) per unit. Also "while the large industrial consumer would be able to obtain his power requirements at ½d. per unit, the national average for all supplies would be in the vicinity of 1d."

The report of the Weir Committee contained a picture of what would be aimed at to secure efficient generation of high tension energy in 1940, as compared with the year 1925. The salient point of the recommendation was that the production of electricity in England has been completely nationalised. Only the distribution has been left in the hands of private supply companies. The cost of production has been reduced considerably, and hence the selling price to the public is being continuously reduced.

"The Commissioners also prescribe regulations in respect of non-statutory lines and works, and also in respect of safety to the public.

"The above-mentioned regulatory powers of the Electricity Commissioners are cited as being the more important; but the acts give them a general supervisory position over practically the whole operation of the supply industry.

"It should be noted, as previously stated, that the Commissioners exercise advisory functions in relation to matters connected with the exercise and performance of the powers and duties of the Minister of Transport in respect of electricity supply.

"The Minister has retained the authority to revise maximum prices, to give approval to the establishment of overhead lines, and to the obtaining of wayleaves; also as to the revocation of powers where default has been made in carrying out the obligations under a special Order or Act. But in all such cases the Minister obtains the advice of the Commissioners.

"These maximum prices may be varied by the Minister of Transport after 3 years from the last variation on the successful application of (1) the company, (2) 20 consumers, or (3) the municipality for the area in which the company operates.

Of recent years, however, a more common method of regulating prices is to make the rate of dividend paid to stockholders by a company dependent upon the actual rates charged to consumers. In 1925 all companies operating in London were placed by Act of Parliament under such a sliding scale of prices and dividends. "Standard" prices are arrived at by taking a sum which will provide sufficient revenue to meet the annual costs and charges of the company in relation to their undertaking (i.e. the fixed and running charges, interest on capital. etc.,) If then in any year the charge made by the company to consumers is less than the charge which could have been made (i.e. the standard price), the difference is described as "consumers' benefit", and the company may, subject to the profits available, carry an amount equal to one-sixth of the consumers' benefit for purposes of additional dividend.

The dividends fixed for the London Companies is 7 percent. It is of interest to note that they are practically guaranteed this dividend by the fixed 'standard' prices, and can only exceed it by making the actual prices lower than the 'standard' prices. These provisions regarding the London companies appear to have worked extraordinarily well, and the low prices which obtain in the Metropolis can be accredited to such provisions.

It has been stated that the Electricity Commissioners are the regulatory body for national purposes. But it is to be noted that in the Act which set them up in 1919 they were empowered to divide the country where desirable. These bodies were to be representative of the utilities operating in the district, Municipalities, large consumers, and employers, and could be empowered to take a transfer of all companies and public utilities in the district if those bodies so agreed. The joint electricity authority would then be the sole utility for a large district.

It is the experience in Great Britain that no business can be run properly where the political element may become predominant over technical and business considerations.

One other body, which was set up in 1906, however, is of a different nature. It is the Central Electricity Board constituted under the Electricity (Supply). Act 1926. It was set up to supply wholesale to private and public utilities. It established the 'grid' transmission lines between certain selected generating stations, and has power to direct the operation of those stations; and transmit the energy over the 'grid' to the best advantage. Its birth was due to the number of small and uneconomical, stations, scattered all over the country working on different Systems. When any of these stations are shutdown, the Central Electricity Board are under obligation to supply the owners at a cost lower than that for local generation. It purchases energy from the selected stations on a specified schedule, the owners of these larger stations having first call for their own requirements. The net effect of setting up of this Board has been to ensure that cheap supplies were not confined to the consumers of those companies who had built large stations, but were to be pooled and spread throughout the country. The principal advantage of the inter-connection of the larger stations, of course, is the reduction of spare plant, the use of the most economical units of plant and the regulation of some of the remainder to peak-load and stand by supply use.

"This Board is really composed of men connected with the industry, and working for the industry; and is fortunately free from politics.

As a result of systematic planning and control of supply companies by the Central Electricity Board, the position of the United Kingdom in the generation and supply of electricity has been steadily improving.

U. S. A.

In the United States of America,which is one of the most progressive countries of the world, electrical industry has had a most amazing growth, and today there is hardly a town with a population of over 1000 where electrical energy is not available to the public. In the U S.A. electric supply is regarded as a public utility commodity, like water supply, gas, railways etc.

Utilities are regulated in the United States, not because they are doing what the Government could ordinarily be expected to; but for the reason that their owners have dedicated the business to a public use. They are, therefore, held to be engaged in what is known in common law as a public calling. Having dedicated their business to a purpose in which the public has an interest, they must submit to control by the public for the common good to the extent of the interest thus created. And so the Government can regulate the rates and service, and many other activities of public utilities to an extent which could not be possible in the case of other kinds of business.

There are at present two types of effective regulations:— (1) The State Public Service Commission and (2) Federal Regulation. The Public Service Commission is a state agency with broad grants of administrative, semi-legislative and judicial power. The functions ascribed to them under the standard are most comprehensive, and include the following: Issuance of certificates permitting the operative control of security issues and long term debts, methods of accounting and depreciation valuations as the besis of rate control, rate schedules and levels, service standards and practices.

Federal regulation centres about power developments on navigable streams, and on water flowing through public lands. This control is centred in the Federal Power Commission. In 1935, under the Public Utility Act, this Commission was also authorised to exercise jurisdiction over power sold for resale purposes across State boundaries. In conjunction with this, it is instructed to formulate a regional and national power programme looking forward to the most economical exploitation of water, gas, oil, and coal resources. Under the same Act, the Securities and Exchange Commission is to regulate holding company organisations, their operations, and finances.

Supplementing direct regulation is the plan for establishing "Yard Stick" enterprises at public expense, e. g. the Boulder Dam and Tennessee Valley Authority. Such power developments aim to supply low-cost power to publicly owned and operated distribution system in the localities, thereby demonstrating the feasibility of much lower rate levels than those generally prevailing. The Central Government has also stood ready to render financial aid to localities interested in establishing their own distribution system.

GERMANY

The power policy of the State in Germany is not to operate utilities, but to leave that to the utilities themselves, including those which are owned by public bodies. In the terms of the "Energie Wirtschafts-Gesetz" (Energy Economy Act) of 1935, the duty of the State is to control the energy economy of the nation from a national view point.

The Act gives the state a firm hold on the general direction and control of utilities by establishing state supervision, and providing for the necessary powers; but leaves to the utilities their specific task of supplying energy under their own responsibility as manager of plants, and at their own financial risk, with full consideration of the interest of the community. Energy supply thus becomes public service a "Versorgungs Aufgabe" (obligation to supply). The aim of the service is to safeguard under economic conditions the supply of energy of the entire territory of the Reisch and of the individual customers.

A system of supervision of plants is created and authority is conferred on the Reisch Minister of Economy for prohibiting building projects, and for the closing down of plants. Also the Reisch Minister of Economy may issue orders regarding extension of plants in the interest of reliability of service. The main object is to promote inter-connection of supply systems.

To protect customers against the abuse of a monopoly, the Reisch Minister of Economy is authorised to deal with general terms, rate schedules, and purchase prices of energy distributors from an economic point of view, and to impose on utilities the obligation to connect and supply every would-be consumer.

The Reisch Minister of Economy is in a position to secure a large measure of information from the utilities. He can enforce his orders not only by means of penalties, but may even order the closing down of plans.

FRANCE

In France, a country deficient in coal, all sources of hydraulic energy are considered as national resources, which could not be disposed of without state authorisation. The authorisation takes the form of concession to parties which confers rights and entails obligations.

The obligations are:—

"To supply energy within the maximum rate, and, wherever technically possible, to every applicant who comes under the conditions laid down in the contract.

"To supply reserved energy at reduced prices, and up to a certain determined amount, to public services, to certain agricultural purposes of public utility, or to certain local consumers.

"To pay to the State, the country and to the river-front municipalities, royalties proportional to the amount of energy produced.

"To hand over the installations free of charge to the state at the end of the concession, the duration of which cannot exceed 75 years.

"As counterpart, the concession confers the right:

"To supplant the water rights of water front proprietors by means of indemnity, even if they possess authorised installations.

"To build by compulsion on riverfront properties dams, headstocks or tailstocks.

"Lastly, but only if the enterprise is declared of public utility, to expropriate private properties where this may be necessary for the carrying out of the work.

The permit may be refused or revoked, not only for motives of safety or management of property; but also to enable efficient harnessing to be effected.

Concession authorities sometimes deem it their duty to accept a competing application, or even invite it when they feel that the local distributor is charging excessive prices, which the contractual revision provided for in the agreement could not sufficiently reduce".

"A concession is granted as a personal title; and the authority which grants it has the right and the duty to see that the applicant possesses the technical ability, the financial standing, the honesty and other general capabilities that are necessary. It can refuse to make the grant without giving any reason. A concession does not establish a proprietary right, and cannot be transferred unless the authority agrees to and accepts the new concessionaire.

"The supervision of electrical distribution undertakings belongs to the Minister of Public Works, and is managed by departmental chief engineers under his control. For the supervision of public distribution, the Chief Engineer of each country has under his orders the following :—

(1) For public distributions, conceded by the State appointed by the Minister, most of them (more than 98 percent) chosen from the service of Bridges and Highways.

(2) For public distributions conceded by other corporations (municipalities, municipal syndicates, and counties) agents appointed by the concession authorities. In the majority of cases (approximately four-fifths) these authorities appoint agents already in charge of State supervision.

Energy distribution concessions for public services and transmission concessions, generally covering several counties at a time, are consolidated into areas formed by a certain number of counties; and are assigned to a chief engineer of the Ponts et Chaussees Service (Bridge and Highway Services).

In the same way hydroelectric concessions are grouped as regions under the supervisions of the Chief Engineers of the Ponts et Chaussees Service."

The rates are under constant revision of the Government.

The numerous variations which have taken place since the War, in prices, salaries and even in the value of money, made it necessary to introduce into the maximum rate a correcting factor intended to function as the electrical economic index. This electrical economic index is a number which is calculated periodically (theoretically every 3 months); and is based upon the prevailing values of coal and salaries. The coal prices taken correspond to definite qualities of coal, and are determined by a commission composed of equal number of representatives of the distributors, consumers and public administrations. The salaries are determined by the administration in accordance with fixed rules, and the results so obtained have never been contested before any tribunal.

The standard agreement provides various cases for rate revision.

In the first place, basic rates, that is, that portion of the rates which is independent of the correcting factor, can be revised upon the request of either the concession authority or of the concessionaire, when the conditions of supply or distributions are modified, which may occur in any one of the four following cases, which are typical examples and are included in every agreement.

(1) If the concessionaire can obtain more advantageous supply by virtue of a new public-service distribution, or a new hydroelectric station.

(2) If the distribution is supplied by a public service energy distribution, and the rates of this concession are revised.

(3) If during the course of a concession, the concession authority places at the disposal of the concessionaire reserved energy at the terminals of a conceded hydroelectric station.

(4) If the distribution is fed wholly or in part by reserved energy, and the rates of this energy are revised.

In the first and third cases it is not essential that the concessionaire takes his supply from the new source; it is sufficient that he can do so; but it is stipulated that in calculating the new price, former contractual relations between him and his suppliers of current shall be taken into account.

The correcting factor can be revised either at the request of the concession authority or the concessioniare in the following typical cases:—

(1) If, according to the different agreements, the electrical economic index varies by more than 30, 40 or 50 percent from its value at the time it was fixed. (The calculations used for the determination of the correcting factor as a function of the electrical economic index are in effect approximate, and would not be valid for wide variations of this index).

(2) If the basic rates are revised.

(3) If the last rate was determined more than 5 years ago. In that case, again, slow variations in the technical and economic conditions of the electrical industry may alter the value of the calculations upon which the correcting factor was based.

If the concession authority and the concessionaire cannot agree upon the revision of the basic rate or of the correcting factor, they can appeal to a committee of three experts, the first two of whom are chosen respectively by each of the parties, and the third by the two together, or, failing that, by the Chairman of the Electricity Commission. If the committee cannot decide

within a given time, the Electricity Commission gives a ruling.

Under this arrangement, it was possible to maintain the definition of the electrical economic index without modification for 15 years from 1919 to 1934. Later a few modifications in detail were made, but it is of no interest to state them here, their main object being to enable a better determination to be made of coal prices and salaries from outside data, that is from figures taken outside the electrical industry, and upon which, therefore, distributors have no influence.

The rates of H. E. Station are constantly under regulation.

A ministerial circular issued in 1921 gave the method of establishing this rate. Account must be taken of all initial costs, including overhead charges, flotation costs, bank charges, as well as all annual charges, including normal interest on the invested capital, either debentures or shares (two points above the effective rate for State loans), sinking fund, share taxes, staff salaries, and costs of maintenance and renewals. The cost price of the energy is thus obtained; and this is increased in a given proportion so as to allow the concessionaire profit on the maximum rate thus obtained.

The Standard agreement provides that this rate be revised once after the operation of the installation has begun, when the real costs can be calculated, and adjustments can be made because of differences that may have arisen from the estimates; and then every 10 years, either at the request of the concessionaire or of the State.

U. S. S. R.

The Soviet Russia has disproved by its achievements the widely held notion that the development of modern industrial civilisation has been almost exclusively confined to countries where the ownership of the land and the productive enterprises is lodged with citizens and not with the state. During the many hundreds of years of the existence of private ownership in Czarist Russia, very little was done for the development of civilisation as compared with what has been

done by the Soviet Government on the basis of State ownership during 19 years of its existence.

"In the Soviet Union it is considered that the satisfactory utilisation of power resources is possible only when there is a unified plan for the development of the whole national economic structure, and not just for power. Such a plan, based on the electrification of the country was the so—called "Goelro Plan" drawn up in 1920. While this plan was met with the greatest of scepticism by many engineers from abroad, it has been surpassed three times over."

When plans for basic investments are drawn up, the location of plants, factories or cities, as well as the selection of the type of power resources to be used, is based upon considerations of the national economy as a whole. The Soviet Union is making extensive use of its water resources.

CHINA

Of the two systems of regulation, namely, franchise agreement between the Government and the Utility, and by regulation according to the legislative laws, China has adopted the latter.

"There are in general two ways in which the public, through the Government, may exercise control over the utilities, namely, by franchise agreement between the Government and the utility, and by regulation according to the legislative laws. In the former case the obligations and privileges of the utility are clearly stated in the agreement, and the utility is subject only to the terms contained therein. This method is in general not satisfactory, since it is generally difficult to draft an agreement applicable for a long period of years; and, in the case of dispute between the Government and the Utility, the Government, being one of the contracting parties, may not be in good position to take effective steps for the protection of the public interest. In the case of legislative regulation, however, the laws may be revised from time to time by proper procedure, so as always to meet the requirements of the day. The present practice in China follows primarily the latter method.

"There are those who favour the practice of franchise agreement in preference to the present method of regulation, on the

ground that the existing laws may be changed in the future, and political pressure may then be applied to the disadvantage of the utility. Such apprehension seems to be baseless, since no laws of a country could be fundamentally affected by revision, unless the form of agreement is fundamentally changed.

"Under the present system of regulation, all private electric utilities are subject to twofold government regulation. The local governments, such as the provincial governments, and the Hsien (Districts) form the local regulating authority, while the National Construction Commission forms the Central Regulating authority; and has the supreme power in all regulation affairs. The local authority, because of more intimate contact with the local utility, exercises direct supervision, subject, however, in the case of important matters, such as the granting of franchise, approval or revision of rate schedule, application of penalties, etc., to the final approval of the central authority. Of course, the opinions of the local authority regarding such matters always receive serious consideration by the central authority in making its final decisions. The adoption of this system of centralised control has for its main reasons the following:—

1. "The activities of the electric utilities of today are no more confined to the boundaries of a town or city, as was the case formerly. In fact, it is becoming common for large electric utilities to own properties and to conduct business in several Hsien or even more than one Province. If the supreme regulatory power were conceded to the local authorities, inconsistency and conflict would be liable to result. Moreover, the utility might take advantage of this unco-ordinated control to act against the interests of the public.

2. At present the budgets of the local governments are generally so tight that they can hardly afford to employ a staff of technical and accounting experts to deal effectively with such a complicated problem as utility regulation. It is, therefore, imperative that the central authority, with its more complete organisation, should be charged with greater responsibilities, while the local authorities simply assist in the execution of orders".

Term of Franchise.

"The term of franchise is 30 years. At the expiration of the franchise period, the central or local government may, upon previous notice, take over the enterprise by paying proper compensation. This compensation is to be determined by valuation, either by the "reproduction method", or by the present value method. Should the Government decline to take over the enterprise, the term of franchise may be extended for 10 years at a time."

Rate Schedule.

"The complete rate schedules as well as service rules of the electric utility must be subject to the approval of the National Construction Commission. Usually the electric utilities themselves prepare the tentative schedules, and submit them through the local authority to the Commission for approval. The local authority, on forwarding them, presents its opinions as to whether the suggested rates are exorbitant or reasonable for the consideration of the Commission. Sometimes the Commission, upon the petition of the local government, the customers or upon its own motion, carries out investigations on the rates, and makes due adjustments in justice to both the utility and the customers ".

Return on Investment.

Thus if an electric utility manages itself in an efficient manner, and charges its customers with reasonable rates, it is entitled to enjoy a rate of return on the capital stock as high as 25 percent. When this percentage is exceeded, then one-half of the excess must be spent for the extension or improvement of its facilities, while the other half must be set aside as a "Customer reserve" to be used later for reducing rates to the benefit of the customers.....As a matter of fact, the National Construction Commission has occasionally, upon the request of the local government or upon the petition of the customers, ordered substantial reduction of electric rates or certain utilities, which, due to poor management, have operated at only a meagre profit in spite of the unduly high rates charged."

Foreign Capital.

"Except by special permission of the National Government, electric utilities are not allowed to make use of foreign capital, either in the form of stocks or loans. This has been wrongly interpreted as a sort of prejudice on the part of the Chinese Government against foreign capital in the development of the electric power industry. As a matter of fact, it is with effective regulation in view that such a limitation is placed on this matter, and foreign capital is welcome to this field if the lenders have a due respect for and understanding of Chinese laws".

Standardisation and Rationalisation.

"All the engineering specifications, as well as the accounting system of the electric utilities, must be in strict accordance with the national standards set up by the National Construction Commission. With a view to standardisation and rationalisation, it is required that in the event of purchasing generating equipment, an electric utility must file detailed specifications with the Commission; and a permit must be obtained from the Commission before placing the order. If the equipment to be purchased does not comply with the national standards, due alterations must be made. If the Commission considers, from the view of co-ordinated economy, the purchase as unnecessary or not advisable, the utility may be asked to withold the purchase."

Meter testing.

The Service Code requires the periodical testing of meters for customers. The minimum provisions of the meter testing facilities of the electric utilities are also specified. The standard instruments used for testing purposes must be sent to the central electrical testing laboratory of the Commission in Nanking or other authorised institutions for calibration.

Management.

The managerial functions of electric utilities are generally left to the utilit ies themselves with little intervention from

the Government authority. Should, however, any electric utility fail to discharge its public duties according to the laws and the code, the regulating authority may demand the dismissal and replacement of the responsible employees of the utility.

Reports.

All electric utilities have to submit, within specified date, annual reports of operation to the Commission and the local authorities. It is from these reports that the national statistics of the electric power industry are compiled. Besides the utilities must furnish data and information whenever required.

VI Administrative Organisations.

In 1932 the National Construction Commission established the Electricity Regulation Board, which was particularly to perform the regulatory functions on behalf of the Commission. This Board is now composed of all commissioners appointed by the Chairman of the Commission. These commissioners are mostly senior officials of the Commission, and are either prominent engineers or economists. Under the direction of the Chief Commissioner of the Board, who alone is a full time official, the routine work is handled by four sections, all having competent personnel. These sections deal respectively with general, accounting, engineering, and business matters.

Besides performing the regulatory functions, this Board is charged with the broader duties of general supervision of the electric power industry of the country, it works on regional electrification schemes of the country, and formulates legal as well as technical codes and regulations for the industry. To the Electric Utilities it is an advisory organisation, always ready to render service by furnishing them useful information and solving difficult problems for them. It settles disputes between utilities or between the utilities and the customers. It strives to bring closer the relationship between the electric utilities and the financing institutions, and between the electric utilities and the power-consuming industries, with the object, of promoting mutual co-operation. Finally, it collects, compiles and publishes the statistics of the industry.

The countries cited above as illustrations vary from the highly developed U. S. A. and Germany to the poorly developed China, and from the socialistic U. S. S. R. to capitalistic Great Britain and U. S. A. We find that although the form of control varies considerably from one country to another, it is effective everywhere and influence she working of the utilities in an intimate degree. As we have already seen above, things are in a very bad state in this country.

11. The Control Machinery for Power Development

The most important step which has to be taken is the creation of a machinery which will devise means for the elimination of various defects enumerated in the present report, and which will work out schemes for a rational development of power in India and of its proper utilization. That machinery will advise the Government about the policy, both general and detailed, which will have to be adopted with regard to power from time to time. In fact, Government should not take any steps without its consultation, its recommendation being normally binding on the Government.

The Power and Fuel Committee had made rather elaborate recommendations about the constitution of such a machinery. The National Planning Committee, however, simplified it very much. The latter recommended the creation of Provincial Electricity Boards and one Central Electricity Board to implement the national policy on Power. A Central Fuel Board was recommended to be created to implement the national policy on Fuel. The Central Electricity Board will co-ordinate the activities of the Provincial Boards and formulate the general national policy. The Central Electricity Board and the Central Fuel Board will work in co-ordination with each other.

The Provincial Boards shall be statutory bodies, which shall be the sole vendors of electricity in bulk, and shall put up, where necessary, special power stations of their own, and shall set up grid systems for the purpose of supplying electricity whereever possible.

(i) To carry out surveys of the water power resources of India.

(ii) To examine schemes for the generation and full utilisation of electricity power.

(iii) To take steps for the progressive reduction of rates, and for this purpose, wherever necessary, to organise existing distributing systems.

(iv) To standardise electrical equipment and practice.

In addition it will be responsible for the import of foreign technicians whenever necessary, and their proper employment. It would be responsible for raising bands of proper technicians from Indian young men, both by having them trained here and abroad. In this connection it will work in co-ordination with the bodies responsible for the promotion of the technical education in this country.

The Central and Provincial Electricity Boards will naturally work through a number of surveys and committees. The Power and Fuel Sub-Committee gave a good deal of attention to their duties. In what follows we have elaborated on what the Power and Fuel Sub-Committee recommended in this connection. The following is a list of surveys and committees through which the Central and Provincial Electricity Boards will work. Each committee would naturally work through several sub-committees.

(*a*) Hydro-electric Power Survey.

(*b*) Industrial Load Committee.

(*c*) Electrical Utilities Control Committee.

(*d*) Railway Electrification Committee.

(*e*) Standardisation and Research Committee.

(*f*) Committee on the training of cadres of workers.

(*g*) Electrical Industries Committee.

The functions of most of these bodies are given in the following sections. The functions of the committees dealing with cadres of workers and electrical industries are left over in the following description, as it is thought that they would be better taken up by Technical Education and Manufacturing Industries Sub-Committees.

12. The Hydro-electric Survey.

It is not proposed to add any notes.

13. The Industrial Load Committee.

The functions of the Industrial Load Committee of the Central Electricity Board would be to plan for the maximum utilisation of the power already developed or to be developed in future. The power is not to be produced simply for its own sake. Its chief aim should be to produce cheaply and efficiently all the goods needed for human consumption and use and to alleviate human drudgery. In India much thought does not seem to have been given to what the power after its production is to do. Large hydro-electric power stations have been constructed at great expense; and when ready for operation difficulty has been experienced in disposing of the output. The load at present is very poor excepting near big towns. Any thing better ought not to have been expected in such a slave country as India, where the development of her industries had been discouraged by her rulers. No efforts have been made to develop new load which could have been done only by developing new industries. Such a course ran contrary to British Policy. No effort was made even to convert load from oil and steam plant to electric drives; the only exception was in Madras and possibly also in Mysore and Bombay.

Load Conversion in Madras

In order to afford facilities for steam and oil engine driven mills and agricultural pumps sets to charge over to electric drive, the electricity department with the sanction of the government instituted a 'conversion fund', from which advances are granted for the supply of electrical plant and equipment on the hire purchase system. The advances are repayable in easy monthly or annual instalments ranging from three to five years. The scheme was most popular, and many loans were advanced to textile mills. The hire-purchase facility was extended to new mills also, but this has now been discontinued. To the end of 1937–38 this fund had advanced Rs. 924,268 of which Rs. 428698 had been repaid. It is necessary to emphasise that neither

government nor their officers merely devise schemes and put them into operation. There is, all the time carefully designed propaganda work going on, coupled with assistance of all kinds to would-be consumers and those actually taking electricity from government mains. We might add that even in Madras much more could be done in this direction.

Some such effort will have to be made by all the governments. Proper data about all the oil and steam plants working at present, and about those which will be installed in future from time to time, should be maintained. Such data should contain information about the prices of respective fuel at the place, the efficiency of the prime movers, the cost of electricity as well the cost of bringing electricity to the premises.

Such a conversion should be helped by the government by introducing such hire-purchase system as is being followed in Madras. In those areas which are served by companies, the electrical undertakings ought to be forced by the government to introduce such a conversion. The terms of such a conversion will be recommended by the above committee.

We need not point out that the conversion of oil and steam plant to electric drive is to be encouraged, both in the interest of efficiency as well as of the country. Oil, which has mostly to be imported, can be less efficiently converted to power in small units, such as are met with normally, than it can be done in power generating stations using comparatively much bigger units. Coal, though an indigenous commodity, suffers from the same drawback as does oil. In small units its conversion to power by steam raising is much less efficient. All inefficiency in the use of coal has to be avoided as far as possible. We have discussed this point under the section dealing with coal. Of course it will have to be seen that the cost of electricity is not such as to make this conversion costlier than to stick on to the older form of drive. In such a case the price of electricity ought to be reduced compulsorily, if necessary.

The Industrial Load Committee will also make a survey of present and future load of all kinds in consultation with provincial agencies, manufacturing and other interests. Such a survey would naturally give greater attention to those

industries which depend, to a very large degree, on cheap power, e.g. electrochemical and electro-thermal. The survey should include, inter alia, data about the availability and cost of raw materials, labour and other fectors necessary for the running of the industries, transportation and marketing facilities, and especially the value of electric process in reducing other costs, and in obtaining co-products and by-products.

A similar work, though not exactly so, has been performed by the Madras Government, Electricity Department, for the Municipalities and other local bodies in that presidency. With regard to developing load, municipal electrical undertakings have been financed. As about the same time as the announcement of policy regarding the development of hydro-electric schemes was made in 1924, the Madras Government also declared that, with a view to encourage electrical enterprise in the presidency, and to assist local bodies to undertake electric supply schemes, that such schemes would be investigated, drawn up and executed by the electrical officers of the Government, as in the case of sanitary schemes, as at that time there were practically no private electrical engineers from whom local bodies could get assistance.

In pursuance of that policy the government have prepared schemes for local bodies which applied for such help, and granted licences to them. In cases where local bodies were not forth coming to undertake such schemes, licences were granted to private companies. In the case of private companies, however, the government have not given either technical or financial assistance.

There are fairly extended periods, when the electricity generating equipment of all the undertakings is under-worked; and it could deliver power almost at cost price during those hours to selected industries, with considerable advantage both to the supply undertakings and the industries thus affected. Of course it will have to be seen that such industries do not affect the peak load of the supply station. The Industrial Load Committee will see that the industries are thus benefited. It will select the industries and fix the rate at which the power is to be given and hours during which it is supplied.

14. The Railway Electrification Committee

One of the very big loads requiring conversion from steam to electric drive, and which will retain its magnitude even in the future industrially developed India, is that provided by the Railways. At present, except for a little over 200 miles of electric railway, all the Indian railways amounting to more than 40,000 miles are hauled by coal-fired locomotives. Since the matter is of great importance from several points of view, it is proposed to devote some space to the problem of traction: First, Railways provide such a heavy already existing load that the question of their conversion to electric drive is of vital interest to the question of power production in India. Such a conversion is important even from the point of conservation of our limited coal resources. Indian railways consume more than seven million tons of good quality coal every year. Such coal ought to have better been used in some other purposes already discussed in the section on coal. Any scheme which allows the Railways to spare, at least the major portion of this coal, deserves serious consideration. In addition, the distribution of coal in India is so uneven that the major portion of the coal used in railways has of necessity to be long haul, and, therefore, costly, whereas power in other forms (e, g. Hydro) is waiting to be used. Electrification will remove these difficulties.

The benefits to be derived from the electrification of purely suburban systems are well-known. The benefits to be derived from the electrification of complete sections of a railway are not realised. There is a popular belief that only where water power is available, or in the case of mountain lines, can complete electrification of a railway system or of a considerable portion of it be justified. We have made an attempt in what follows to disprove such an idea. From 1925 onwards the main line railways in and around Bombay were electrified, and now extend to a radius of more than a 100 miles from Bombay*. Such an electrification has resulted in economy to the railways; and the scheme of electrification would have been pushed further, but

*The consumption of electricity in traction (railways) in India during 1938-39 was 155,176,000 K. W. H.

for possibly heavy capital expenditure involved in such a conversion. Electrification of railways is an accepted policy all over the world. In England, too, the Weir Committee reported in favour of general railway electrification in 1931.

Advantages of Electrification

Electric traction results in increased speed. The capacity of an electric motor to take an overload of anything upto 100% of its normal capacity enables the electric locomotive to show very rapid acceleration from rest; and, at the same time, a greater uniformity of speed over the different classes of trains. The increased punctuality of trains due to the capacity of electric traction is an advantage. To take a heavy overload and to maintain uniform speed will enable the railways to give a far more frequent service by reducing the headway of each train without incurring additional risks. Electrification increases the use made of railway capital, by increasing the traffic above what can be dealt with by a given amount of capital, and by releasing valuable building sites. It enables services to be run with fewer locomotives than are required under steam operation, due to the cumulative effect of four different factors.

The first is that electric locomotives have much greater haulage capacity. Steam locomotives are prevented by their railway gauge, and by the height of their tunnels and bridges, from reaching much higher capacities than those now obtained. Such dimensional limitations do not affect the future development of the electric locomotive; and this, together with the efficiency of the electric motor, enable far heavier loads to be handled by electric train than by steam. The increased scheduled speeds of all trains enable each locomotive to complete a greater mileage per annum than was possible under steam operation. Some saving can also be achieved through the need for fewer types of locomotives than in the case of steam operated locomotives in railway service, which have to meet varying operating conditions, such as in express, passenger, suburban and freight train services, or in the marshalling yards. A separate type of steam locomotive is required for each, whereas, with the electric motor, it has been found possible to standardise on a smaller number. In Sweden

standardisation has been made on two types only; and the fullest measure of interchangeability has been obtained, thereby increasing considerably the use made of each tractor. The fact that an electric locomotive does not require time to be spent in lighting fires, raising steam, coaling and watering, clearing fires and movements to the round house, enables it to be in service for the whole 24 hours, when necessary. An electric locomotive can, on the average, be in service for 80% of the year.

The cumulative effect of these four factors on the number of locomotives, required both for goods and passenger traffic, is very great. It is interesting to note that the Weir Report, in estimating the cost of electrification, allowed some 30% fewer tractors; and in view of the experience on the P.L.M. in France and the railways in Italy as well as many others, this appears to be a conservative estimate.

The fact that the railways can, when electrified, run their services with between 30% and 50% fewer locomotives, produces a comparable reduction in the combined engine and shed staff. In fact, operating costs in France have been reduced by one-sixth by the economies on this item alone.

Another result of electrification is a notable decrease in the maintenance cost for tractors, rolling stock and the permanent way. Economies in the maintenance of rolling stock are chiefly in the form of a reduction in the renewals of Drawbar and couplers, owing to the even pull of the motors. Economies on the permanent way are due to the electric locomotives being much lighter than either the steam or diesel tractor which has to haul its own power.

The following table gives the relative costs of steam and electric locomotives respectively. The figures have been compiled on a basis of work done; and it may be taken that they are representative. The figures for repairs and maintenance, depreciation and interest on capital, include all charges. For steam locomotives the account includes coaling, watering and repair. For electric locomotives, the account includes overhead or third rail conductors, battery charging, converting or transforming plant, repair plant. 100 is taken as a basic figure for each item.

	Steam coal fired	Electric trolley
Repairs & maintenance	100	33
Power	100	33
Lubrication Etc,	100	33
Wages	100	50
Depreciation	100	60
Interest on capital	80	100

The overall operating costs are as 100 to 50 for steam and electric systems respectively.

Tests in consumption of energy by steam and electric locomotives have shown that 1 K. W. H. is required from the battery of an electric locomotives to do the work of 13 lbs. of coal in a steam coal-fired locomotive*. The thermal efficiency

*The above figures relate to industrial locomotives which do only such work as shunting in big industrial undertakings (e.g. the Tata Iron and Steel Co. works in India). They have been taken from "Electricity" of August 19, 1921, and relate to small systems where only one locomotive is used. On larger systems, however, greater economy would be effected by the use of electric traction, as a number of steam locomotives can be displaced by a smaller number of electric locomotives. The larger the system the greater becomes the ratio of steam to electric locomotives required for the work; and the difference offsets the higher cost of the electric locomotive

Attention is also drawn in this connection to a paper by Hobart read a few years back before the American Institute of Electrical Engineers, where the steam and electric locomotives for heavy main line express service have been compared. The calculations therein showed for a steam locomotive an efficiency from coal to crank-pin of 4.4% and from Coal to draw-bar 3.53%. The fuel used in steaming up and wasted at the end of the journey, reduced the net efficiency further to 2.65% equivalent to a fuel consumption of 6.86 lbs. per draw bar H.P. hour.

For the electric locomotive the calculation similarly showed an over-all efficiency from coal pile to outgoing cables of 11%. Taking into account the various losses in generating, transforming sub-stations, machines transmission to train and tram equipment the over -all efficiency from coal pile to drawing wheel will be 7.

For dense service 6.1%

For spare espress 6.6%

The coal consumption was estimated to be 47% of that required for steam working. With dense traffic and more stops, electricity would have a still greater advantage over steam. Furthermore, fuel could be delivered cheaper at the power house than on the tender; and a cheaper grade of fuel could be used, so that the ratio of fuel costs would be 3 to 1. Smith (Jour. I. Elec. Eng. Vol. 52, p.299)similarly remarks that the cost of coal burnt in a large modern generating station producing electricity for hauling trains by an electric locomotive is less than half the cost for doing the same work in a steam locomotive.

of an ordinary saturated steam-locomotive is about 5% in the main line work, so that even in the consumption of fuel, electrification of railways brings about considerable saving.

On the revenue side the result of electrification will be to increase the competitive power of the railways.

The results of electrification extend beyond the field of operating economies and competitive advantages to the railways themselves. The absence of smoke and the decrease of noise increases the value of all the properties along the line, especially in urban districts. The more frequent and rapid service brings the country nearer to the towns, and assists in the decentralisation of industry. It has been realised that the recent development of transport, especially in electric traction, has rendered the agelong controversy between city life and village life obsolete; and it is now possible to push on with the development of Suburbs, i. e. rural areas having the amenities now found only in cities. As the railways touch most of the towns in this country and the mileage is vast, their electrification will bring electrical energy at the disposal of all such towns and villages. The electrical undertakings running in several such towns will be inter-connected, their main interconnecting transmission lines can be run on the same posts as do the wires for feeding the electric locomotives.

The initial effect on railway labour itself would be a considerable transfer from old to new classes of employment, and a reduction in the amount of labour employed, which however, should be rapidly made good through the increase of traffic. Of the direct employment that would be given by the conversion operation, apart from imported raw material (which should be almost negligible), almost the whole expenditure would be distributed in this country in the form of wages.

There is yet another point arising in connection with railway electrification. It is about the equipment replaced by the electric tractors. At present the annual requirement of broad-gauge locomotives in India is more than hundred; and that for meter-gauge ones about 40. If electrification is taken

up at some particular place, the items thus replaced can be distributed all over India; and fresh purchases be stopped altogether. The pace of electrification can be so adjusted that this replacement does not spell any economic loss. India has gathered some experience in railway electrification. The question of railway electrification will be very much simplified as most of the Indian railways are State property. The rest will soon become Government railways. It is only for the Government and the country to decide on this policy of railway electrification. A committee of experts (The Railway Electrification Committee) should go into this matter forthwith to settle details about the railway electrification. It should work in conjunction with the industries and the railways.

15. **Electrical Utilities' Control Committee**

Even in India it has been found that the Government machinery provided in the Indian Electricity Act is not only cumbrous, but leads to several difficulties in its operation. In Madras the difficulties were such that the Chief Engineer of the Electricity Department suggested the formation of a statutory body, such as the Central Electricity Board in England; or the Electricity Supply Commission in the Union of South Africa; or similar bodies elsewhere to take over the control and administration of electric supply.

A committee was appointed in 1935 and reported in 1936 As was to be expected vested interests, particularly company licenses, were not in favour of government according sanction, to the formation of a Board or Commission. The Chief Engineer, on the other hand, was strongly of the opinion that the creation of such a Board was essential. Eventually the Committee. although not advocating the formation of a Board at that time, left the matter open. The relevent recommendations of the committee are set out below.

"(1) That, although we do not advocate the creation of a Statutory Board at present, we are, as a committee, in full agreement that a Statutory Board may be desirable at some future date; and we recommend that Government should not lose sight of the possibility of such a Board being formed.

(2) That an Advisory Board should be set up as soon as possible with as wide a scope as possible."

15. (d) Collection of Financial details about Undertakings.*

Although under the present Electricity Act the accounts of Electricity Supply undertakings are to be audited by Government Auditors, the usual practice is to let the companies' auditors act as auditors on behalf of Government. Thus in the matter of audit Government have been deprived of a most valuable help and guidance, which they have a strict right to, from their auditors. The present recommendation attempts to remove this defect.

The auditors appointed by the Committee will have not only to see that there is a voucher for every payment, but will have also to see that the payment itself is such as an ordinary businessman of prudence would incur. The financial audit in this latter sense is much more important from the committee's point of view than the mere voucher audit.

The auditor should append to the annual statement of accounts a report dealing *inter alia* with the following points:-

(1) Whether he has satisfied himself that only those items which properly belong to the capital account have been debited thereto; and that nothing has been charged to revenue account which should properly be debited to the capital account.

(2) Whether in his opinion, the rates for energy charged to the consumer are resonable, and not capable of appreciable reduction. His reason for arriving at his conclusion should be explained with reference to the revenue, profits, and appropriations made from the revenue to various reserve funds.

(3) Any other particular point or points on which special information is at any time desired."

It might be added that the Bombay Government has adopted a similar procedure (vide the Bombay Government Press Note reproduced in sec. 8).

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*15 (a), 15 (b), 15 (c). left out of the text of the Report—*Editor.*

15. (e) Reduction of rates charged for electricity

In this connection it might be worthwhile to point out that it is but fit and equitable that the consumers, too, should be given an opportunity of saying whether they consider the prices of electricity to be just. A recommendation by the P. E. P. on Electrical Supply in Great Britain on this subject would not be without interest; and we quote it below :—

"Where consumers allege that the prices charged are in excess of what they deem equitable, they should have the right to demand an enquiry by the Electricity Commissioner, and the commission should have no power to refuse that enquiry if the number of consumers making the petition in the area of a Rural District Council is in excess of 10, or in any other area 20. The commissioners should publish the results of the enquiry ; and their decision should be binding on the supply undertaking."

The problems of reduction in the rates for electricity naturally raise the question as to what should be the basis for charging rates. It is perfectly reasonable that the rates charged for electrical energy should be such as to ensure a fair return on the investments on public utilities. It is very difficult, however, to lay down what this fair return should be. In determining a fair return, the fact that the public in the early stages, when electricity was regarded as a luxury, took a considerable amount of risk in investing their money in these enterprises, should not be lost sight of. Again, like any other investment, the capital must bear a certain amount of interest, which should not be less than the current market rate of interest. The investors must be insured against any possible loss of their capital such as by obsolesence or loss of franchise, so that capital will naturally be drawn to the public utility fields.

In America and in England various rates have been adopted at various times; but no attempt is made to describe them here. We merely illustrate this point by describing what obtains in England. "Of recent years a more common method of regulating prices is to make the rate of dividend paid to stockholders by a company dependent upon the actual

rates charged to consumers. In 1925 all companies operating in London were placed by an Act of Parliament under such a sliding scale of prices and dividends. 'Standard' prices are arrived at by taking a sum which will provide sufficient revenue to meet the annual costs and charges of the company in relation to their undertakings (i. e. the fixed and running charges, interest on capital, etc.). If then, in any year, the charges made by the company to consumers be less than the charges which could have been made (i. e. the standard price), the difference is described as "consumer's benefit," and the company may, subject to the profits being available, carry an amount equal to one-sixth of the consumer's benefit for the purposes of additional devidend. The dividend fixed for the London companies is 7%; and it is of interest to note that they are practically guaranteed this dividend by the fixed 'standard prices,' and can only exceed it by making the actual prices lower than the 'standard prices'.

The dividend fixed by the Government of Bombay in the case of Electricity Supply Companies, which are to operate in that presidency in future, is to be limited to 6%? (vide the Bombay Government Press Note reproduced, in Sec. 8).

In this connection we would further draw attention to the following recommendation of the P.E.P. on Electrical Supply in Great Britain.

"The Electricity Commission shall determine maximum prices to be charged by supply companies, in order to realise an average of not more than 5% on the ordinary and preferred share capital prior to the 1st January 1936, and N% on new capital thereafter. Profits earned in excess of this return should be allocated in the following proportions.

"20% to additional depreciation and renewals and reserves; 10% to the payment of additional dividends on stock, 70% to the reduction of prices to the consumers. Where a delay of more than 12 months occurs between the allocation of profits and the reduction of prices, the whole of subsequent years' profits, after the payment of 5% on the capital, should be allocated to reduction of prices only."

"In the case of local authorities, the next surplus, after payment of interest and sinking fund charges, should be allocated in the following proportion: 20% to the additional depreciation, renewals and reserves and expenditure on distribution in unremunerative areas; 10% to contribution towards rates, and 70% to reduction of prices to the consumer. Where however, payments for local taxation assessed on the electricity undertakings increase in any year by an amount equal to or greater than 10% of the next surplus, the proportion allocated to the reduction of prices to the consumer shall be increased from 70% to 80%, and no contribution to rates.

A matter no less important than the rates for electricity is the relation between the consumer and supplier of electricity. Under present day conditions, a potential consumer, however vital his business may be for the country, and however reasonable his hours of demand may be even from the point of view of the electricity supplier, has either got to take the terms offered or leave them, notwithstanding the fact that the supplier may have a large amount of surplus electricity during off-load periods. Although business considerations will normally force some settlement, still the State ought to be invested with power so as to arrange things in such a way that the consumer is not at the mercy of the supplier where his needs are vital for the public good, or if the consumer represents some key industry.

In this connection the following suggestion merits serious consideration. It is based on a similar recommendation by the P.E.P.

The Electrical utilities control committee should determine in cases of differences and disputes between an authorised undertaker and a consumer or potential consumer:—

1. The amount of electricity to be taken or guaranteed, the periods during which it will be taken, its price and the purpose for which it is to be taken:

2. The sufficiency of the security offered; and

3. The cost of service lines.

15 (g) Relation between the Electrical Undertakings and their Managing Agents.

The Bombay Government has (vide Press Note reproduced in sec. 8) put down conditions regulating the relations between the Electricity Supply Companies and their Managing agents. According to these conditions, any agreement between the licensee for the generation and supply of electricity and the managing agents shall be subject to the approval of the government.

15(h) Change of hands on the part of Electrical Undertakings

It has been the practice in India for an individual or a syndicate to obtain the requisite licence from Government in the first instance, and then to form a limited liability company to take over the licence from the syndicate. The consideration for the transfer of the licence usually consists in the payments of a certain amount in cash, and the allotment of shares depending on the authorised capital of the newly formed company. This practice leads to the building up of invisible stock or stock-watering.

The measures recommended here will check this tendency, and a similar measure has recently been adopted by the Government (vide Bombay Government Press Note, reproduced in Sec. 8). According to that measure 'no licence shall be transferable except to a company which may be floated for the purpose; and then only on the basis of actual expenditure incurred by the licencee in securing the licence, and of any other capital expenditure incurred.

15 (i) Holding Companies–their control.

The P. E. P. report on Electrical Supply in Great Britain has given a good deal of attention to such Companies; and has suggested a good number of measures for their control. The following measures may be of interest in this connection.

In the case of holding companies there should be a compulsory publication of details regarding their financial operation.

Exchange between one company and another of shares which are not represented by productive assets of equivalent value, should be prohibited, the determination of this value being left in the hands of the Electricity Commission.

This issue of capital by holding companies without the specific approval of the Commission should be prohibited. This approval to be contingent on the application of all the new capital to the business of distributing and supplying electricity, and all new issues should be made in accordance with conditions attached to such approval.

In the case of the same interest carrying on several businesses or running several undertakings, each one of them should have a separate account; and each one of them should furnish financial statements to the Electricity Commission, which should be subject to examination by Government auditors. The auditor appointed to audit the accounts should be the same as that appointed to audit the account of the holding company. The report of such auditors should state the capitalisation, the value of the assets and investmensts, the interest on loan and advances, and the changes in the capital structure and ownership during the year. The form of such report should be laid down by the Electricity Commis sion. The capitalisation must be shown separately from that of the holding campany; and an exact return of all borrow ings from the holding company with the annual charge represented by them must be given. Such borrowings from the holding company, as well as increases in capital expenditure other than borrowing or advances, must have approval of the Electricity Commission.

"Where a holding company ceases to be purely a holding company, and becomes an operating company, in charge of an integrated system with central control and administration of what were previously constituent companies, it should be treated as an operating company, subject to the restriction that it cannot sell or transfer the property of the former constituent companies at a valuation higher than that determined by the Electricity Commission. The consent of the Commission should

be required for all new capital by operating companies' and the commission should attach such conditions as they think fit."

The P. E. P. report lays down the rate of interest which should be allowed on capital advanced by holding companies in its report on the supply of electricity in Great Britain in the following words :—

The maximum returns allowed on capital advanced by holding companies on short-term advances and loans should not be greater than 1 per cent above bank rate, and on long-term loans than 1 per cent above the current rate of yield on consols.*"

15 (j) Alterations in the plant and equipment to be sanctioned by the Committee.

That the present recommendation is not a unique one can be seen from the fact that even in the case of such a country as China, the National Construction Commission of that country exercises such a control. (vide sec. 10).

Partly with the same end in view, the P.E.P. report on the supply of Electricity in Great Britain suggested that the Electricity Commission should have powers to act as a central purchasing organisation for the supply of industry generally. All purchases made by the electrical undertakings should be made through it. This suggestion is of much greater advantage to India than it could have been to United Kingdom. Here it would mean not only a good deal of saving, but will indirectly lead to a healthy establishment of an industry manufacturing electrical goods and machinery.

15 (k) Hire-purchase system of initial installations.

Such a policy was adopted by the Government of Madras in order to stimulate the demand for electricity and the conversion of oil and steam plant to electric drives. According to this policy loans were granted for construction and conversion. To quote from the 1937-38 Administration Report of the electricity Department of Madras Government :—

* *For long term loans it might be desirable to raise this limit under certain conditions.*

"In order to afford facilities for steam and oil engine driven mills and agricultural pump-sets to change over to electric drive, the Department, with the sanction of Government, instituted a "conversion fund" from which advances are granted for the supply of electrical plant and equipment on the hire-purchase system. The advances are repayable in easy monthly or annual instalments ranging from three to five years. The scheme was most popular and many loans were advanced to textile mills. The hire-purchase facility was extended to new mills also; but this has now been discontinued."

To the end of 1937–38 this fund had advanced Rs. 9, 24, 268 of which Rs. 4, 24, 698 had been repaid.

15 (1) Ways and means to put into effect our recommendations.

Regarding the recommendation that some of the directors of the Electricity Supply Undertakings should be nominated by the Government, it might be pointed out that the Bombay Government has specified that it will nominate one director to the Board of directors of each electricity undertaking operating in that Presidency.

Similarly, the Bombay Government has stated that it will have the option to purchase any electrical undertaking after the expiration of a specified number of years from the commencement of the licence, and thereafter on the expiration of every subsequent period of another specified number of years therefrom.

The price to be payable for such a purchase is to be based on a standard which needs some explanation. It might be contested that a 'fair-return' should be based on the amount of share capital invested by the shareholders in a company. This claim is untenable because, on the one hand, there might have been undue watering of stock; while on the other hand it would manifestly be improper to deny to the shareholders a return on the capital expenditure met out of accumulated reserves of the company. Therefore the value of the properties at the service of the public is the correct basis. The process of valuing the proper-

ties is, however, beset with difficulties, as even eminent jurists do not agree to the exact meaning of the term 'value'. It is not necessary to enter into any controversy here as the problem has been simplified by the fact that the amount of depreciation reserve has in most cases been invested in the business itself. As these investments are properly being maintained by the creation of further reserves, the present value of assets ought to be taken as the 'original cost' less the 'accrued depreciation reserve'.

The justification for such a reduction is that the share holders are not equitably entitled to a return on the value of the assets acquired by investing the depreciation fund in the business. When a company invests its Depreciation Reserves in the business itself, in effect, it borrows the amount so invested from the Reserves; and should, therefore, pay interest to the Reserve which it would have earned, had it been invested outside. The result of providing interest is that the charge to the operating expenses on account of depreciation is diminished. Therefore the value of the properties on which a return ought to be calculated ought to be reduced by the amount of the depreciation Reserve.

16 **Standardisation, Specification, and Research.**

In order to utilise the Indian power resources having different characteristics and locations, it will be necessary to have the various supplies connected and coordinated. This would bring about considerable economy in the use of equipment; and ensure that the fullest use is made of capital investment in generating stations. It will bring about a greater reliability in service. In the event of a breakdown of any particular station, other connected stations will take up the load. Such an inter-connection will convert most of the secondary power into primary power, as is actually the case in places like Madras.

Effective interconnection of all the generating stations and distribution systems cannot be accomplished until the character of supply and frequency of these systems are standardised. In this country there is no such standardisation. This

point has attracted attention even in the past, though possibly for a different reason. Mr. J. W. Mears, the then Electrical Advisor to the Government of India, wrote in 1921, in his Preliminary Report on the Water Power Resources of India (p. 31), as follows:—"It is very desirable in the interests of British trade that British Standards of pressure and frequency be adopted in all future hydro-electric works, and the suggestion is put forward that this should be a condition of all leases and agreements for the development of water power". We also support this recommendation of Mr. Mears, not from the motive of assisting British trade and industry, but for better utilization and coordination of existing machinery, and preventing waste and confusion in the future, both by allowing the future Indian electrical manufacturing industry to produce machinery and equipment for a small variety of types for use at factory and home. There would be, under such a system of standardisation, no occasion preventing the consumer from using certain equipment after removing his household to an area of supply where electricity is distributed at a different voltage and frequency, or is of a different character altogether.

Such a standardisation has been brought about in England which had very many different systems of supply. It was done at a cost of £18 millions. The work involved the installation of new electric motors on a large scale in such industries as iron and steel, ship building and engineering; and entailed the rewinding of alternators in generating stations, and of other equipment used for the transmission and conversion of electricity. Some such scheme will have to be worked out for this country and carried into effect before anything can come out of inter-connection of supplies.

It will be the function of the above Committee to work out completely the problem of standardisation and to enforce it. It will make a decision about the standard to be adopted in the system of electricity generation and supply. The Committee will also find out whether there is a case for standardisation of systems in those areas where non-standard supplies are now given; and, if so, it would indicate how and over what period the conversion should take place.

Another important function of this committee would be to work out and set up standard specifications for all the machines, plants and instruments required in the electric power industry, which will have to be manufactured in this country.

There are some so-called standardisation laboratories in India, e. g. the Government Test House at Alipore, and the laboratories attached to the offices of Electrical Advisors to the various Provincial Governments and Electrical Inspectors. But apart from testing meters, which may occasionally be sent to them, they do nothing towards the standardisation of meters, instruments and the various methods of electrical measurements. The British Standard Specifications are applied indiscriminately, irrespective of the conditions obtaining here being absolutely different from what they are in England. All the above mentioned laboratories are not equipped to work out any standards for this country.

To carry out the above mentioned work of standardisation a number of laboratories will have to be equipped and started to take up this work, and suitable bodies similar to the British Standards Institution will have to be set up to look after this work.

We have recommended in a previous section (15j) that any alteration in or addition to the existing plants of electrical undertakings should have a prior sanction of the Electrical Utilities Control Committee. In our opinion that particular Committee will give a sanction only after consulting the Standardisation and Research Committee.

In addition to the standardisation work a lot of research work will have to be undertaken in order to solve the various problems arising in the production, transmission and distribution of electricity, and in its use. Many problems will arise when various electrical instruments and appliances are manufactured in India from Indian materials. These will have to be undertaken in the various laboratories of this country. More laboratories will have to be started.

The conduct of research work will be looked after by several sub-committees, all working under the general direction of Standardisation and Research Committee. The following table* gives an idea of the amount and variety of work to be met with and the number of sub-committees which will have to handle this work.

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*Table not given in the Text—*Editor*

RESOLUTIONS OF THE NATIONAL PLANNING COMMITTEE ON THE INTERIM REPORT

of the

Sub-Committee for Power and Fuel.

The interim Report of the Power and Fuel Sub-Committee was presented by Dr. Megh-Nad Saha, Chairman of the Sub-Committee, on the 12th of May 1940. Prof. A. K. Shaha, Secretary of the Sub-Committee, was also present. Discussion continued on the 13th May. The following resolutions were passed:

1. We agree with the view that the rates for energy in India are unduly high, and power has been very inadequately developed, and this has stood in the way of promotion of industries, particularly electro-chemical and electro-thermal ones. This is due to the failure, on the part of the Indian Government, to adopt a National Policy on Power and Fuel in spite of the suggestions put forward by the Industrial Commission of 1918, and in spite of the world-wide movement for rational and coordinated development of power resources in all countries of the world.

2. We recommend that in view of the fundamental importance of power developments, the huge capital investment required, and because it may involve the interests of more than one Province and State, and for other reasons, the State should develop a definite National Power and Fuel Policy on the following lines:—

(a) That all power and fuel resources of the country should be regarded as national property, and should be fully conserved, scientifically developed and utilised, with a view to bringing power, particularly electrical power, at the service of everybody for domestic and industrial use, at the cheapest rate;

(b) As the generation and distribution of electricity is a public utility of great importance, the State should ultimately own it and the control and management of it should be exercised by the Electricity Boards, as hereinafter provided for;

(c) That the State should take the initiative to bring into existence all future schemes of regional power developments and public power supplies, particularly hydro-electric stations; inasmuch as the working of such stations depends on the use of water resources which, however, have multifarious other uses affecting extensive areas, and large populations, e. g. for irrigation and navigation, for drainage and soil conservation; further because the State alone is in a position to reconcile and integrate all features of power schemes, financial success, cheap servicing, use over widespread areas and land acquisition and settlement of populations;

(d) That in view of the limited reserves of coal, which cannot be replenished, and which are indispensable for such essential industries as smelting of iron ore, production of synthetic dyes, and other essential chemicals; and because of the finding of the coal mining committee of 1937 that coal is being mined, processed, and marketed in a very wasteful way, greatly injurious to the interests of the nation as a whole, very strict State control should be exercised on all phases of the coal industry. Further in regions far removed from coalfields, coal for power production should, as far as possible, be replaced by hydro-electric and other sources.

3 We are of opinion that in order to implement the National Policy on Power, it is necessary to create Provincial Electricity Boards, and one Central Electricity Board; and for implementing the National Policy on Fuel, there should be a Central Fuel Board. The Central Electricity Board will coordinate the activities of the Provincial Boards, and formulate the general national policy. Wherever necessary, two or more Provinces or States may form a Regional Board.

The Central Electricity Board and the Central Fuel Board will work in co-ordination with each other.

The Provincial and Regional Boards shall be statutory bodies, which shall be the vendors of electricity in bulk, and shall put up, wherever necessary, special power stations of their own, and shall set up grid systems for the purpose of supplying electricity wherever possible.

The functions of the Electricity Board will be as follows:—

(i) To carry out surveys of the water power resources of India.

(ii) To examine schemes for the generation and full utilisation of electrical power.

(iii) To take steps for the progressive reduction of rates and for this purpose, wherever necessary, to reorganise existing distributing systems.

(iv) To standardise electrical equipment and practice.

4 The Hydro-electric Survey of India:

The Hydro-electric Survey of India should be an all-India body, with a suitable head-quarters, and should be of the same status as the Trigonometrical and Geological Survey of India and should work in co-operation with the National Water Power Resources Commission. Under its direction, survey work should be carried out by provincial agencies, wherever possible, or by its own staff when provincial agencies are not available. The survey ought to be undertaken according to the natural hydrological divisions of India, e. g. the Ganges basin, the Indus basin, the Western Ghats, Deccan Plateau. It should be a permanent body, like the Royal Water Power Board of Sweden, or the Federal Hydro-dynamical Survey of Canada. The survey should be carried out in a comprehensive manner, as laid down by the World Power Conference; and all records and data should be analysed at the headquarters stations and used for development of power.

5 We favour a policy of electrification of railways.

6 The Indian Electricity Act should be amended to give effect to the policy enunciated in the above resolution.

7 Coal: We consider that, in the interests of the nation, it is imperative that coal mines and the coal mining industry, as well as the oil fields and other sources of natural fuel, should be completely nationalised. This industry should be conducted by a National Fuel Board, with sections for Production; Processing, Research and Utilisation; and Distribution and Marketing and Transport. Research work should be started immediately.

8 Liquid Fuels:—

(i) The State should establish a geophysical prospecting department, with modern equipment and a competent staff,and carry on an intensive search for petroleum sources in the country.

(ii) The development of the Power Alcohol Industry should be encouraged by the State, and all impediments in the way of this development must be removed, as this power alcohol is the most important liquid fuel which can be developed easily from various indigenous agricultural and forest products.

(iii) Intensive propaganda work should be started to replace kerosene by non-edible vegetable oils, and research should be carried on to devise suitable burners for this purpose.

(iv) A new orientation to the scheme of soft coke manufacture should be given by making it obligatory for all to recover the by-products for the purpose of further treatment in distillation plants.

APPENDIX I

Questionnaire for the Power and Fuel Sub-Committee

7. Please give details of the various markets in the country of imported goods giving your information on the following model:—

> The price of coal, petroleum fuel and electricity (for industrial purposes) both at the markets and where the raw materials for the production of each of the articles are available.

8 What have been the prices of coal, petroleum fuel and electricity at the places where the various industries existed? (give the figures for the last five years.).

9 How do the prices at the various hydro-electric schemes compare with each other and with those charged by other electric supplies in this country?

10 What is the cost of the generation of electricity per unit at the various places; how does it compare with each other and with the cost in the foreign countries?

11 What are the causes that have contributed to the high cost of production of electricity in India as compared to the foreign countries? Had they been visualised at the time the various schemes of electricity production were worked out and what were the various steps taken to overcome them?

12 What steps have been taken to reduce the cost of production of electricity since the working of the various schemes?

13 What are the advantages and disadvantages of the two schemes of electricity production (i) Grid scheme, (ii) Isolated stations scheme, and why has one or the other scheme been adopted at different places in India?

14. What information has been collected by various parties, both Government and private, as to the suitability of different schemes of electricity production and distribution

(grid and isolated station schemes, hydro, steam power, and oil power generation) and to the best location of the generating stations? Please place all this information at the disposal of the National Planning Committee.

15. What organisations are at present working or propose to work in future to collect the above mentioned information and data?

16. What steps have been taken or are proposed to be taken to start a net-work of industries producing goods which are imported at present and which are consumed in a particular area, as a preliminary to the electrification of that area, in view of the aims of electrification being the creation and regeneration of industries?

× × × ×

107. What scope is there for developing adequate industries for the manufacture and supply of the fuel, or motive power for the various means of transport within your Province?

140. What are the sources *of power supply* in your Province, apart from human labour in respect of

(*a*) animal power,

(*b*) mechanical power, and

(*c*) electrical energy

How far have they been adequately developed?

141. In what direction is it possible to develop these sources, so as to distribute additional power supply with a view to make it available on the cheapest possible way?

142. Are there any mines in your Province for the Production of coal, petroleum, or natural gas? To what extent are these sources of power supply worked in your Province, and by what agency? What are the directions of Government control over these agencies for the proper development and economical working of these sources of power supply?

143. Is there any other source or material (molasses, prickly pear, etc.) from which new power may be obtained on a considerable scale? How for are such sources already investigated? What steps would you suggest for developing these sources of additional Power in your Province?

144. What facilities have been provided for the development of technical research in regard to the most economical and efficient use of the available fuel supply, and other sources of energy?

145. What facilities have been provided in your Province to encourage technical, industrial research, so as to make the conduct of agriculture, industry and all forms of business the most economical and efficient, as well as progressive?

SUMMARY OF DEVELOPMENTS

POWER AND FUEL

The importance of developing electrical energy for a country so vast, and yet so deficient in coal supply, cannot fail to be recognised in a country preparing to be industrialised in the modern manner. But the development of an alternative source of energy will have to be assigned the highest priority, if the programme of agricultural development and Industrialisation is to be carried through as per plan.

There is no dearth of moving water whether in natural waterfalls or through artificially built bunds; and that energy can be transformed into electrical power. This is more easy and acceptable in this country, as hydro-electric works, now projected in the several parts of the country, are expected to serve a number of purposes, besides generating electrical energy. The earlier Irrigation Works on our principal rivers were construct. ed almost entirely to serve the single purpose of supplying water for the crops in the drier regions of the country, or in the event of the failure of the monsoon rains. In recent times, however,—and particularly because of the impetus given to it by World War II,–as well as by the force of such examples as the Tennessee Valley Project in the United States, the more recent projects have been framed not only to provide water for crops, but also to generate and distribute electrical energy, to protect the countryside against the ravages of floods, to reclaim waste or marshy land, to settle population on the lands thus reclaimed, and supply them with all the aids of efficient agriculture and industry, and serve a number of other purposes according to the peculiarities of the region served and projec t framed too varied to allow of detailed enumeration in this place.

Stimulated by this new impulse, almost every Province and several of the leading States, have prepared Plans to increase the supply of electrical power in their regions. The total capital proposed to be invested in these projects is estimated,

roughly, to amount to Rs. 66.5 crores, or 8.7% of the aggregate outlay on Provincial Plans. Some Provinces have worked out detailed schemes, which are either already in process of execution or soon will be. The first popular Central Government of the country, the so-called Interim Government of India,–as soon as formed, in 1946, set about co-ordinating these various schemes, several of them common to more than one unit; and so begin a network or grid of electrical energy supply for the entire country. The subjoined Tables gives an idea of some of the projects now under way, or being surveyed.

BRITISH INDIA (Government Projects)

(*in Kilowatts*)

Province	Total installed, capacity of generating plant (as on January 1st 1946.)	Addl. capacity planned by Govt. & estimated to be ready by the end of		
			1950	1955 or later
Assam	2,924	No definite schemes have yet been drawn up. A survey is being conducted of the possibilities of hydro-electric development in the province.		
Bengal	3,34,973	(*a*) Damodar Valley Project being planned by the Central Technical Power Board.	3,000 (If work on the Tilaiya Dam commenced immediately)	35,000
		(*b*) Moor Reservoir Project.	Not known	Not known
		(*c*) A special staff of engineers has been appointed to carry out a general survey of the possibilities of electrical development and to prepare concrete schemes, for transmission and distribution of electric power.		

Province	Total installed capacity of generating plant (as on January 1st 1946.)	Addl. capacity planned by Govt. & estimated to be ready by the end of		
			1950	1955 or later
Bihar	27,162 (Not including private electrical installations as Tatas & Rohtas Ltd.)	Bihar Grid and Fertilizer Power Station, Sindri.	80,000	110,000
		Kosi River Project	...	250,000
Bombay	324,149	The Provincial Govt. plans to rationalise the generation of electricity and to increase supply by building power stations both Hydro and Thermal, but no details or specific figures have been given. The exact schemes have not been decided on.	47,000	Not known

C. P.	23,565	Central Thermal Power Station at Khaparkheda near Nagpur.	20,000	10,000
Madras	144,541	(*a*) Pykara Power Plant extensions.	20,000	...
		(*b*) Moyer Hydro electric Schemes	24,000	...
		(*c*) Papanasam Hydro electric Power Stn. extension	5,800	...
		(*d*) Mettur Power Plant Extn.	10,000	...
		(*e*) Installation of two "Package Sets" at Madras	5,000	...
		(*f*) Machkund Hydro-electric Scheme (Joint with Orissa)	...	103,000
		(*g*) Bezwada Power Station extension. (Part of the Machkund Hydro-thermal Project).	9,000	...
		(*h*) Nellore Thermal Scheme	5,000	...
		(*i*) Pericard Hydro-electric Scheme. (Joint with Travancore. To be taken up after 1950).	...	40,000
		(*j*) Tungabhadra Project.	...	26,000

Province	Total installed capacity of generating plant (as on January 1st 1946.)	Addl. capacity planned by Govt. & estimated to be ready by the end of,		
			1950	1955 or later
N.W.F.P.	10,824	Extension of Malakand Power Station.	5,000	...
		Dargai Project.		15,000
Orissa	1,221	(*a*) Machkund Scheme Transmission lines only. (A joint Madras Orissa Project) See item (f) under Madras.	...	...
		(*b*) Cuttack Thermal Scheme	2,000	4,000
		(*c*) Ganjam Thermal Scheme	1,000	2,000
		(*d*) Sambalpur Thermal Scheme	1,000	...
		(*e*) Mahanadi Valley Scheme (A multi purpose Project, details of which are not yet available but for which a project report is being prepared by the Central Waterways, Irrigation and Navigation Commission)	...	50,000
Punjab	89,461	(*a*) Rasul Hydro-electric cum tube-well Project.	22,000	...
		(*b*) The Nangal Hydro-electric & Power Project.	72,000	45,000

		(c) The Magla Hydro-electric & Pumping Project.	...	18,000
		(d) Mianwali Minor Hydro-electric & Pumping Project.	6,600	...
		(e) Installation of two "Package Sets" (oil fired) at Shalamar.	5,000	...
		(f) Bhakra Dam Canal and Hydro-electric Project.	...	300,000
Sind		Rohri Canal Hydel Scheme with Thermal stand-by. (Details of the scheme are still not settled.)		10,000
U. P.	169,375	(a) Nayar Dam		20,000
		(b) Sarda Canal Hydel Scheme.	41,400	
		c Rihand Dam. (In the early stages of investigation)		150,000
		(d) The Tons Giri Dam (Joint scheme with the Punjab is still under investigation).	Not known	Not known
		(e) Muhammadpur Project.	10,500	...
		(f) Installation of two "Package Sets" at Gorakhpur	5,000	...
Delhi	29,528	Delhi Central Electric Power Authority.	20,000	Not known
Total	1,175,037*		420,300	1,503,000

*This excludes the installed capacities in Ajmer Merwara, Baluchistan & Coorg aggregating 2,718 KW.

BRITISH INDIA (Electric Supply Companies and Corporations)

	Province and Undertaking:	Additional installation under erection or on Order or likely to be ordered shortly:
Bengal	Calcutta Electric Supply Corporation.	2,50,000
	Gouripore Electric Supply Company	18,750
Bombay	Ahmedabad Electric Supply Company	37,500
Madras	Madras Electric Supply Corporation	15,000
United Provinces	Cawnpore Electric Supply Corporation	15,000
	Total ...	3,36,250

Hyderabad	13,051	(*a*) Nizamsagar Hydro-electric Power Station.	15,000	...
		(*b*) New Thermal Station in Godavari Area at Ramgundam	37,500	...
Kashmir	4,270	Sind Valley Project	6,000	9,000
Mysore	61,000	(*a*) Jog Falls Scheme	1,20,000	...
		(*b*) Mekadatu Falls	...	22,500
Travancore	16,947	Pallivasal Scheme Extensions	22,500	72,250
Cochin State	2,919	Poringalkutheu Scheme	18,000	28,500
Other States	48,459		4,800	67,000
Total...	1,46,646		2,23,800	1,99,250

If and when all these projects mature and come into working order it is estimated that the increase in electric power by 1950 will be very substantial. Though the data available are somewhat incomplete, it is nevertheless possible to give a rough estimate of the increased power likely to be ready in 3 years time, if present plans are adhered to and successfully carried into execution. In order to give a complete picture, figures for Indian States as well as for the Provinces of British India are included. The main facts are as follows:

At the beginning of 1946 the total installed capacity of the generating plant of Government and Public Utility undertakings in India was approximately 1,324,400 kw. located as under:

British India	.....	1,177,800 kw.
Indian States	.....	146,600 kw.

By the end of 1950 it is estimated that an additional capacity of nearly 980,000 kws. will have been installed, made up as follows:

British India:

(*a*)	Addl. capacity planned by Government	420,300 kws
(*b*)	Addl. capacity planned by Electric Supply Companies and Corporations. ...	336, 250 kw.
(*c*)	Indian States	223, 800 kw.
	Total...	980, 350 kw.

This increase is considerable, but the estimates may well prove over optimistic, as plant deliveries are somewhat uncertain at present. Furthermore the following facts should be noted:

(1) The estimated increase in Indian States, although practically confined to Mysore, Travancore and Hyderabad, is relatively much greater than in British India.

(2) The additional capacity planned by the Calcutta Electric Supply Corporation accounts for no less than 250,000 kws. out of the total estimated increase of 757,000 kws in British India.

Estimated increase by 1955.

By the end of 1955 or later, greater increases, exceeding perhaps 1,500,000 kws. may be expected, if some of *the large* projects, such as the Bhakra Dam, the Damodar Valley Project and the Kosi Project, materialise.

Another important development, on the lines recommended in the Report, may also be noted in this summary, viz. the increasing tendency of the leading Municipal Corporations in this coutnry to take over their local Electric Supply and Transport systems from private corporations. Bombay has given a lead by taking over its forty years old private concern, to be operated directly by the Municipal Corporation. It will not only be an important Public Utility for the city, but can be used as an integral factor in developing the City and the Suburbs,–the Greater Bombay,–in accordance with a preconcerted plan of development. Heavy compensation has had, no doubt, to be paid for buying out the private corporation. But the service expected to be rendered by this development is much too precious to defer such expansion on grounds of cost. The Calcutta Corporation is following suit, at the moment of writing. The general policy recommended by the Report is likely to be an accomplished fact in the near future, especially as the larger projects of allround River Development have been planned as public enterprise with joint action by the Central and Provincial Government.

Full co-ordination of water resources, and their utilisation for a multiplicity of purposes, as recommended in the Report is being effected by the Central Irrigation Board. This body was created in 1927 to advise Provincial Governments on Technical questions. Its activities were considerably expanded in 1931 by co-ordinating research through a Central Bureau of Information; they were further widened by the inclusion, as members of the Board, of the Chief Engineers of certain States. Its constitution was amended in 1945, when the Engineers of the Government of India dealing with Water ways, as well as the Chief engineers of Provinces concerned with Hydro-Electrics, were made members. Though policitically independent of India, Ceylon and Burma send their representatives to this Board.

The Central Water-ways, Irrigation and Navigation Commission was set up in 1945 by the Government of India to provide a central, national, fact-finding organisation, planning and co-ordinating the water wealth of the country, and advising Government, whether of the Provinces and States, or at the Centre-, on all problems relating to Water-ways, Irrigation, Navigation, and Hydro-Electrics. The Commission makes investigations for the control of water-ways; prepares projects; organises and co-ordinates statistical information relating to water-ways; advises the Government of India and the Crown Representative (while that office lasted) on disputes regarding water rights between Provinces and States, and on the relative priorities for irrigation, flood control, and production of hydro-electric energy. Comprehensive resolutions laying down general policy for the better co-ordination of the water wealth of the country, were passed at the 1945 and 1946 sessions of the Board, which are reproduced below.

Yet, another noteworthy development of a constructive character, also on lines suggested in this Report, is the establishment of the Electric Grid system in a number of Provinces. The Bombay System which may be taken to be typical, is intended to rationalise the generation of electricity by generating it at a few selected stations having natural advantages; to make this electric power available in progressively large quantities at lower rates; and to bring this energy within the reach of a steadily increasing proportion of the population, both urban and rural.

APPENDIX II

Resolution passed by the Central Board of Irrigation at its 1945 meeting.

Resolution.

(a) Resolved that, in the interest of rapid multi-purpose and integrated development of the water resources of river basins in India, a recommendation be sent to the Government of India that Provinces and States be requested to forward to the Central Waterways, Irrigation and Navigation Commission each major river development project for the conservation, control and regulation of water, for its comments regarding the repurcussions of such projects on similar developments in other Provinces and States connected with the river basin concerned, and recommendations for modifications or amplification of the project.

(b) Resolved that the attention of the Government of India be drawn to the resolution passed under item xvi of the 15th meeting of the Board held in November, 1944, and copy of which was forwarded to the Secretary, Labour Department, with the Board's No. 6786-F.41, dated 17th November, 1944, which reads as follows :

"It was resolved that the Government of India should be informed that the Board consider that the best way in which to ensure that the interests of all Provinces and States within a catchment basin shall receive due consideration will be by the formation of River Commissions which will be organised as a result of an agreement between all parties concerned.

The Board recommend that where conflicting interests are known to exist, the Commissions should be formed with the least possible delay."

The Board repeats the recommendation made in that resolution, and urges that steps should be taken to form the Commissions recommended on all major river basins in India.

(c) Resolved that the Board emphasizes the desirability of legislation to give the Government of India powers to create River Development Authorities or "Corporations" on a regional basis.

(d) Resolved by a majority that the Board considers that the existing machinery under the Government of India Act for settlement of disputes between Provinces and States in respect of waterways or water rights is not satisfactory, and recommends that the Government of India should take steps to improve the procedure so as to expedite settlement of such disputes.

(e) Resolved further that the sub-committee which has been appointed to deal with the proposals regarding reorganization shall ask the Hon'ble Member for Labour to give the same sub-committee an opportunity of explaining and amplifying the Board's proposals concerning Regional Development."

Resolution passed by the Central Board of Irrigation at its meeting 1946.

1. Resolved * that: the Board welcomes the proposals to include in the Union Subjects "Communications", which term must necessarily include the Waterways of the country.

The term "Waterways" comprises any stream or channel which is navigable, or can be made navigable; and the water running in and draining into that stream or channel.

2. Resolved that the Board recommends that statutory provision be made and necessary legislation enacted to provide for the following:

(i) To set up, when necessary, in cases where more than one Province or State are concerned, Catchment and-or Sub-catchment Boards to formulate proposals, and, if required, to execute works, for the control, conservation and regulation of river supplies for the benefit of all parties concerned.

(ii) To set up a Statutory Technical Organisation which will co-ordinate and regulate the activities of the Catchment

*Passed by a majority of 14 against 2.

and-or Sub-catchment Boards; this organisation to have powers to obtain and collect information relating to all Waterways in India.

(iii) To set up a Statutory All-India Arbitration Board to decide all issues concerning Waterways that are referred to them for decision.

(iv) To ensure that the Provinces and States shall be free to enact legislation in respect of generation and distribution of power and water within their respective territorial jurisdictions, and to develop the resources of Waterways which are entirely within their territorial boundaries, or have been allocated to them for such purpose.

3. Resolved further that: the Board recommends that the proposed Electricity Bill (1946) be modified so as to conform to the provisions stated in paragraph 2.

(It is beyond the capacity of the present writer to offer any comment of his own on the several large projects of multipurpose utilisation of rivers now being put into execution. A specimen, however, is given below of a critical summary of the project relating to the Damodar Valley scheme, which is typical of other similar projects, and will suffice to give a general idea regarding the nature of such schemes.)

HIRAKUD PROJECT

Next to the Damodar Valley Project may be mentioned the Hirakud Dam Project and their multi-purpose river-training scheme of all round development and uttilisation of our water resources for power, irrigation and navigation. As now planned, and according to the latest proposals on the subject, given in the Project Report dated June 1947, and issued under the authority of the Central Waterways Irrigation and Navigation Commission, presided over by Mr. A. N. Khosla, the enterprise consists briefly of the following:—

Building of a dam 125 ft. above mean bed level of the Mahanadi River at the Hirakud Island, partly of concrete or masonry and partly of earth protected with stone rip rap on

both faces. The capacity of the reservoir is stated to be 5. 3 m. acre feet, of which 1. 2 m. acre feet will constitute dead storage, and 4. 1, live storage.

The dam is expected to irrigate 1,094, acres of land. Of these 619,035 will be irrigated by gravitation, and 475,918 will be watered by lift irrigation. On each side of the stream two canals will be constructed, one supplying water by gravitation flow and the other by lift. A fifth canal is planned to be taken off for lift irrigation between the Mahanadi and the Ib Rivers; while still another canal is projected to take off below the subsidiary reservoir at the lower power-station, with a capacity of 1,676 cusecs to irrigate 167,600 acres. It will generate 350,000 k. w. of power in two stages :—

(i) The first below the main dam itself of a capacity of 150, 000 K. W.

(ii) The second, 17 miles down-stream, with a capacity of 200,000 K. W.

The lower channel of the first stage is proposed to be of a capacity of 18,000 cusecs; the capacity in the second stage is not clearly stated. The tail race channel from the lower power house is proposed to be run for 8 miles further down-stream befor it joins the river.

Once constructed, the dam well afford protection to the delta with a reserve capacity of 2. 72 m. acre feet, which forms part of the live storage of 4. 1 m. acre feet in the reservoir. In addition, it will provide navigation facilities from the Port of Chandbali to Dalab, a station near the lower power house, and from thence to the reservoir head by suitable locks.

This project has been criticised in detail by Mr. M. G. Rangaiya, Chief Engineer and Secretary, P. W. D., Mysore. Government, on, amongst others, the following grounds:—

(1) That the site on Hirakud Island is not suited for the dam. There are a number of technical reasons advanced in support of this contention, which may be summarised by saying that the river at this point is much too wide for a dam of this character, and that there are

two hills on both sides extending over several miles. The Bund, if necessary, would be of an enormous size; and if made of porous or semi-porous soil, with stone facing on both faces, rip-rap, it will be lacking in homogeneity.

(2) These are disadvantages, which, in the opinion of the Engineer, are intensified by the fact that the earthern bund and dykes are the weekest link in the chain. The dykes are not easily accessible, being situated in hilly country; and so their maintenance is neglected. It would thus from a source of danger, as all such earthern embankments are liable to be overthrown, if there is a sudden flow or breach, or because of the underground havoc of colonies of ants.

(3) The site is also liable to earthquakes, while the diversion of the river floods, included as one of the items of this project, involves a very heavy task. American examples are not reliable precedents in this matter, mainly because America is a very rich country that can afford to spend enormous sums of money on such schemes, but we in India are too poor in comparison to afford such luxuries.

(4) Yet another disadvantage of this project, as it stands, is the low artificial head (85 ft.) at the first stage of power generation, and a long length of power channel of 17 miles to the second stage of the power-station. Then follow another 8 miles of only raised channel through uneven country, and all to provide a comparatively small head of 85 ft. only.

(5) Financial considerations are no less important; nor less in the way according to this critic. A total capital outlay on the dam is estimated at Rs. 16.16 crores, making the reservoir capacity of 5. 3. m. c. ft. or an average cost of Rs. 702 per m. c. ft. With the present high prices of materials and labour, this rate seems to Mr. Rangaiya to be unworkable. He supports his contention by the analogy of the Krishnaraja

sagar dam at Mysore on every point; and so apprehends an increase in the cost of 50% or Rs. 24.24 crores in the eventual total. There seems certainly no chance of prices falling. The return also from these works when completed, will not be so large as to make the project economically advisable. Preliminary expenses of Rs. 1 crore are regarded as wholly underestimated; while the compensation which would have to be given for the land acquired for building this reservoir, estimated at Rs. 5½ crores, is also considered to be much below the actual cost on that account. As regards the cost of foundations of cement concrete of sluice gates, and of buildings, railways and roads connecting this, everywhere the calculation is needlessly low and likely to be much heavier than has been estimated by the authority already mentioned.

Measures for malaria control, medical relief and sanitation in the areas reclaimed or resettled, which will have to be taken are likewise estimated much below their likely incidence and the abatement of land revenue due to the submersion of cultivated land in the reservoir, proposed to be capitalised at 20 years purchase, is also found to be very much more heavy than allowed in these estimates.

There are other points advanced by Mr. Rangaiya of a more technical character, which it is impossible to summarise here, even if the writer had the capacity to do so. The substance of his argument is summed up in the warning that projects of this magnitude, which necessarily stretch over a comparatively long period, must be considered from every possible point of view, and not merely the ultimate results as expressed in terms of the new acreage brought under cultivation, or the electrical energy generated or, alternatively, the employment offered. The newly watered land would need some capital; the electric energy would be unwanted and unused if side by side there are not developed industries to utilise this new and cheap motive force.

On the Irrigation aspect scheme, also, Mr. Rangaiya is very pessimistic. The lowest duty assumed for calculating the

capacity of canals is 100 per cusec for paddy; 120 in the monsoon season for sugar cane, and 200 for other crops. This is contrasted with the head duty of 67 in the Orissa Delta. The chances, therefore, of realising a fair return seem rather doubtful.

On the whole Mr. Rangaiya seems to fear the project would spell bankruptcy for the Province of Orissa; and that alternative schemes should be evolved to ensure prosperity for the Province. He suggests the project be referred for further scrutiny to a committee of officials and non-officials interested in such matters. His summary of conclusions, given below in his own words, is a warning which ought not to be ignored.

Summary and Conclusion

36. The Hirakud island site is not an ideal one, as is the Satkosia gorge situated at Tikarpara, for the construction of a reservoir dam and the proposals now made for the Hirakud dam will involve risk and endanger the safety of the dam in years of extraordinarily high rainfall. The site admittedly submerges sources of valuable minerals, such as diamonds, gold, etc. Though their origin may not be readily traceable now, future discoveries should not be made impossible. What is of no apparent significance or value now may become very significant in years to come.

As regards irrigation, the duties assumed are too high and cannot be attained in practice. The extent of irrigation proposed should either be curtailed or the reservoir and canals enlarged much beyond their proposed capacities.

The lift irrigation proposals are of an unusual character and will involve very heavy initial cost and no prospect of return at any time, as even the gravity flow irrigation will be a continuous loss to the State with low rates proposed and no possibility of higher rates being levied.

The working tables as now prepared do not afford a correc basis for judging the success or failure of the reservoir or of its effects on the extensive irrigation in the delta depending

on natural flow in the river. The tables, even as they are, show that there will be failure both of gravity and lift irrigation supplies in many years.

There are no natural advantages for generation of hydro-electric power, such as falls. Their artificial creation is too costly and the proposal to have a lower power station for taking advantage of the low bed fall involves long feed and Jail channels subject to risk of damages and will be unduly costly both in first cost and maintenance.

The hydro-electric power generation proposed is not of a steady character but is subject to long interruptions and large variations. It has to be necessarily supplemented by an auxiliary steam power plant or by purchasing such power from other installations. No commercial concern can agree to supply power to supplement frequently varying demands arising at short notice at any reasonable rate the project can afford to pay. The only alternative course is to generate steam power in the neighbourhood of the dam. If this is done it will have to be kept idle for 9 to 10 months in the year and sometimes whole years and thus very uneconomical to maintain. The best course would be to abondon the idea of hydroelectric power generation and take up the thermo-electric.

The navigation part of the scheme is of very doubtful utility and heavy cost will have to be incurred both initially and in annual maintenance.

The costs of this colossal scheme are generally underestimated under almost all heads. The actual costs may work up to nearly Rs. 100 crores and, including interest during construction, the total outlay for purposes of accounting will be Rs. 115 crores nearly.

The return expected at the rates proposed in the project is about Rs. 320 lakhs, while the expenditure both direct and indirect would work out to Rs. 628 lakhs resulting in a perpetual drain on the resources of the Province. Even doubling the power rates would not save the schemes and no industry can survive if the rates are doubled.

The ryots in the province cannot pay any higher rate for irrigation supplies. There is thus no prospect of large revenues being realised at any time.

The times are most inopportune for starting such large schemes considering the international situation and the much disturbed labour and communal situation and the menacing currency inflation, which are all heavily pressing on the Central Government.

The scheme is not going to solve the immediate food problem, nor even the long range one except at the risk of perpetual drain on the finances both of the Orissa Province and of the Indian Dominion. No hasty action should be taken before considering deeply all the alternatives and determining their comparative merits or demerits.

37. In conclusion, I regret to have to state that the Hirakud Dam Project as now worked out by the Chairman, C. W. I. N. Commission, does not seem to deserve to be sanctioned "forthwith" but that further detailed study and investigations are absolutely necessary on an all-India basis to determine the best scheme or schemes which would bring prosperity to the people of India and increase the economic wealth of this great country—which is just beginning to regain its long-lost liberty but is caught in the tentacles of labour, communal and financial troubles.

If, in spite of the note of caution herein given, it is finally decided to proceed with the Hirakud Schme, I can only say that it would be taking a leap in the dark. The least that can be done is to refer the project to a commitee of competent Indian experts of high standing and established reputation like the eminent engineer-statesman, Sir M. Visvesvaraya. With him may be associated two other Indian electrical civil engineers of wide experience and also high financial and revenue officers—all unconnected with the preparation of the Hirakud Project.

The present writer is not technically qualified to express his own opinion on this matter, but he realises the necessity of

a really comprehensive National Planning put simultaneously into execution on all fronts and in all its items, much too muc not to be impressed with Mr. Rangaiya's reasoning, if only because it provides a concrete example and agrument to reinforce the policy advocated throughout this Series.

Damodar Valley Development.

In January 1945 the Government of India requested the C. T. P. B. to investigate and report on a multi-purpose development of the Damodar Valley. The "Preliminary Memorandum on the United Development of the Damodar River" was issued in August 1945. This Memorandum indicated the vast potentialities of the region and the good economic prospects for a co-ordinated plan. The Memorandum was discussed at a joint meeting of the three Governments concerned (the Centre, Bengal and Bihar) and the C. T. P. B. was requested to prepare project reports on various dam-sites. A project report on the Maithon Dam and a preliminary project report on the Tilaiya Dam were submitted to Government in April 1946; and these were accompanied by the remarks of Consulting Engineers from the United States, Messrs. Riegel and Schlemmer and their Indian associates Rai Bahadur Khosla and Mr. Narasimhaiya. The C. T. P. B. was further requested to prepare detailed designs for the Tilaya Dam, and following a request from Bihar a preliminary project report was also submitted on the Konar Dam. The detailed designs on the Tilaiya Dam are progressing satisfactorily and it is now expected that these may be completed early in 1947. Meanwhile an extensive drilling programme at the Maithon and Tilaiya dam-sites is in the last stages of completion, test pits are being dug at the Konar Dam-site and a considerable amount of preliminary access roads and pre-construction facilities have been completed at the Maithon site. The latter project is now ready for detailed design but this will be a large undertaking involving an expenditure of some 25 to 30 lakhs of rupees. The C. T. P. B. is not, of course, staffed to undertake such a large task in addition to its own work.

An inevitable step towards further and more rapid progress on the Damodar Valley Project which must necessarily be taken is the establishment of a Damodar Valley Corporation with all its constitutional and financial implications. At the present time this is complicated by the uncertain constitutional position in the country as a whole. These matters have now been placed on the agenda of a meeting between the three Governments concerned which is being scheduled for early January 1947.

The suggestion which has been put forward on several occasions that the Central Government should proceed with the project and finance it itself leaving a settlement between the three Governments to the future recently ran up against a further serious obstacle. This is the uncertainty of the financial powers of the future Union Government

ADDENDUM

*This does not include production by factories, collieries and industrial power plants; some of the major producer on this head are Tata Iron & Steel, with an installed capacity of 94700 killowatts, and Indian Iron & Steel Co. with 26000 killowatts. Others are small. The output from the two above plants will be about 500 million units, if the load factor be taken to be 45. In 1938, the total production was about 3000 million units, so that the increase in four years of War was only 1500 million units.

This note is to be read as foot note to page 9.